NOAA Technical Memorandum NMFS-SEFC-235

Report of the Southeast Fisheries Science Center Marine Mammal Program Review, 2-3 May, 1989

by: **Gerald P. Scott and Larry J. Hansen**

U.S. Department of Commerce
Robert Mosbacher, Secretary

National Oceanic and Atmospheric Administration
John A. Knauss, Administrator

National Marine Fisheries Service
James W. Brennan, Assistant Administrator for Fisheries

August 1989

Notice

The National Marine Fisheries Service does not approve, recommend or endorse any proprietary product or proprietary masterial mentioned in this publication. No reference shall be made to NMFS, nor to this publication furnished by NMFS, in any advertising or sales promotion which would indicate or imply that NMFS approves, recommends or endorses any proprietary product or proprietary material mentioned herein, or which has as its purpose an intent to cause directly or indirectly the advertised product to be used or purchased because of this NMFS publication.

This report should be cited as follows:

Gerald P. Scott and Larry J. Hansen. 1989. Report of the Southeast Fisheries Science Center marine mammal program review, 2-3 May, 1989. NOAA Technical Memorandum NMFS-SEFC-235, 81p.

Copies may be obtained by writing:
National Technical Information Service
5258 Port Royal Rd.
Springfield, VA 22161

This publication is contribution CRD-88/89-17 from the Southeast Fisheries Science Center, Miami Laboratory, Coastal Resources Division.

Table of Contents

I. Introduction 1

II. Historical Perspective of Program 1

III. Issues 5
III.1. *National Management Issues* 5
III.2. *Marine Mammal Commission Critical Issues* 6
III.3. *Regional Management Issues* 6

Discussion of Items I, II, and III. 7

IV. Research Presentations: Bottlenose Dolphins 8
IV.1. *Stock Differentiation Research* 8
IV.1.1. *Herd Biodynamics Studies* 9
IV.1.1.1 *Indian/Banana River* 9
IV.1.1.2. *Mississippi Sound* 10
IV.1.2. *Behavioral Indices* 11
Discussion of Stock Differentiation Studies 12
IV.2. *Review of Localized Surveys* 12
IV.3. *Review of Mississippi Sound Abundance Estimates* 14
Discussion 15
IV.4. *Review of Chandeleur Sound Abundance Estimates* 16
IV.5. *Review of Regional Surveys Abundance Estimates* 16
Discussion 18
IV.6. *Review of Chandeleur Sound Model* 18
IV.7. *Surveys for Turtles and Oil Rigs* 20
Discussion 21
IV.8. *Review of Quota Recommendations* 21
Discussion 22
IV.9. *Review of Monitoring Activities* 22
IV.9.1. *Site-specific Monitoring* 22
IV.9.1.1. *Site-specific Monitoring, Sarasota/Tampa Bays* 23
Discussion 24
IV.9.1.2. *Site-specific Monitoring, Indian/Banana Rivers* 24
IV.9.2. *Strandings* 24
Discussion 25
IV.10. *Review of Dieoff and Ramifications* 25
IV.11. *Review of Human-induced Mortality Estimates* 27

V. Research Presentations: Large Whales 28
V.1. *Review of Prior Research Recommendations* 29
V.2. *Right Whale Cooperative Research* 29
V.3. *Endangered Whale Recovery Plans* 30
V.4. *Image Processing* 30
V.5. *Catch History of Right Whales* 31
Discussion 32

VI. Perceived Research Needs 32
VI.1. *Monitoring Research* 33
Discussion 35
VI.2. *Assessment Research* 36
Discussion 36
VI.3. *Dolphin Dieoff Research* 37
Discussion 37
VI.4. *Human-induced Mortality* 37
Discussion 38
VI.5. *Stock Differentiation Research* 38
Discussion 39
VI.6. *Large Whale Research* 39
Discussion 39

VII. Review Team Findings and Research Recommendations 40
Findings 40
Research Recommendations 41

References 45

Appendix I 50

Appendix II 52

Appendix III 56

Appendix IV 78

I. Introduction

Since the Marine Mammal Protection Act (MMPA) of 1972 took effect, more than 500 Atlantic bottlenose dolphins (*Tursiops truncatus*) have been permanently removed from southeastern United States waters for purposes of public research and scientific display. The Southeast Fisheries Research and Science Center (SEFC), the research arm of the National Oceanic and Atmospheric Administration's National Marine Fisheries Service (NMFS) in the southeastern region, began its Marine Mammal Program (MMP) in October 1978 to satisfy the requirement that it offer management advice on the live-capture fishery for bottlenose dolphins to the management arms of NMFS: the Southeast Regional Office in St. Petersburg, FL, and the Washington, D.C. Protected Species and Habitat Programs Office. Marine mammal research at the SEFC has been shaped to its present form by recommendations developed during a continuing series of internal and external reviews, during the 1978 SEFC Program Planning Meeting, the 1979 East Coast/Gulf Coast Cetacean and Pinniped Research Workshop, the SEFC Stock Assessment Workshop(s) in August 1982 and July 1984, by the U.S. Marine Mammal Commission (MMC) in February 1983, and by consultation with the other NMFS Regions in January 1985. In response to the recommendations made during these consultations and reviews, marine mammal research conducted at the SEFC has expanded to include some large whale species, but the main focus of research remains the bottlenose dolphin.

Several milestone events have passed since the most recent review of the MMP that require reevaluation of the goals and priorities of SEFC marine mammal research. Among these are the reauthorization of the MMPA, completion of several major research analyses of marine mammal data sets, the commitment of NMFS to preparing recovery plans for endangered cetaceans, and the east coast dolphin die-off of 1987-88. To assist in determining future research directions, a program review was held at the SEFC on 2-3 May 1989. The agenda for the review is provided in Appendix I. Participants are identified in Appendix II. An annotated bibliography of the research supported by the SEFC MMP since 1979 is provided in Appendix III.

II. Historical Perspective of Program

The SEFC MMP is concerned with the marine mammal communities of three NMFS designated ecosystems: the Gulf of Mexico Shelf, the South Atlantic Shelf, and the US Caribbean Shelf (Figure 1). The marine mammal communities of these systems are comprised of 25-28 cetacean species, 4 or more pinniped species, and 2 sirenian species. Of these marine mammals, most MMP research has been directed at the bottlenose dolphin, with much of this research concerning the US bottlenose dolphin live-capture fishery.

Besides the US bottlenose dolphin live-capture fishery, there are some directed fisheries for small cetaceans in the Caribbean outside US waters. Until recently, humpback

whales (*Megaptera novaeangliae*) have also been taken in limited numbers in non-US Caribbean waters. Incidental catch of bottlenose dolphins and other species is known to occur in fisheries in the three ecosystems of the SEFC's concern, but catch rates are generally not known.

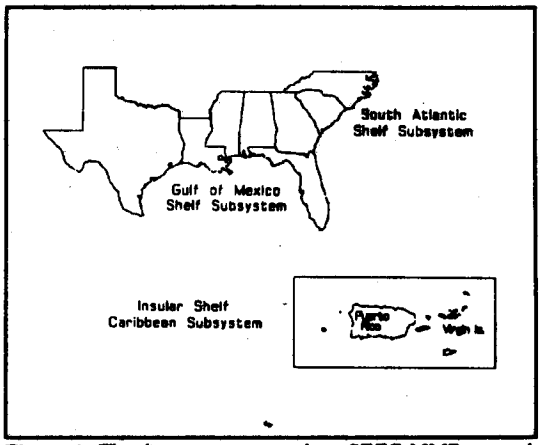

Figure 1. *The three ecosystems where SEFC MMP research has occurred or is planned.*

Management authority of marine mammals by NMFS is legislated in the MMPA. NMFS also has marine mammal-related responsibilities under the Endangered Species Act (ESA), the Fishery Conservation and Management Act (FCMA), and international authorities such as the International Whaling Commission and the Convention on International Trade in Endangered and Threatened Species. Under the MMPA, NMFS is required to conduct research on marine mammals within US southeastern waters, particularly regarding determination of the status of populations. This information is necessary for the development of management plans concerning incidental catch and the live-capture fishery. Fishery management plans developed for other species under the FCMA are required to consider effects of fishing on marine mammals. Under the ESA, consultation with NMFS is required to determine effects of proposed actions on endangered cetaceans and pinnipeds.

The research directions of the MMP were influenced by a number of significant events. A workshop on bottlenose dolphin assessment in 1975 (Odell *et al.* 1975) set the tone for the early research directions of the MMP. This workshop was held to assess the status of bottlenose dolphin research, and to recommend research directions. The workshop called for studies of census techniques to establish consistent and comparable methods, determination of local population abundance, and the establishment of long-term studies. The initial SEFC marine mammal research planning meeting held in December 1978 at the Southwest Fisheries Center relied heavily on the recommendations of the 1975 workshop. The SEFC utilized these recommendations in developing goals for the MMP: 1) develop and improve methods to assess bottlenose dolphin population levels, 2) determine the dynamics and discreteness of stock units, and 3) determine the validity of the 2% rule. The SEFC MMP was first reviewed in September 1979, at the Workshop on East and Gulf Coast Cetacean and Pinniped Research (Prescott *et al.* 1980) held at the New England Aquarium. This 1979 workshop was held in response to congressional concerns that the $500K added to the NMFS budget for east coast marine mammal research had not been used for that purpose. In 1982 and 1984, the SEFC sponsored Stock Assessment Workshops (SAW) (Powers 1982, 1984) which assembled appropriate experts from the southeast region to review the available information on the status of bottlenose dolphin stocks. One of the primary goals of these workshops was to recommend research directions for the MMP. The 1982 and 1984 SAW recommended the MMP

conduct and/or expand research on: 1) stock structure of bottlenose dolphins, 2) stock status of bottlenose dolphins region-wide and the development of abundance indices, and 3) establish work on right whales (*Eubalena glacialis*). A review by the Marine Mammal Commission in 1983 confirmed the research directions of the MMP. A large whale research planning meeting in 1985 established research priorities for large whales in the southeast (Scott 1985). This meeting placed the highest priority (in the southeast) for research on right whales in their calving grounds. However, the massive bottlenose dolphin dieoff of 1987-88 resulted in a shift of nearly all of the MMP's efforts towards examining that phenomenon from mid-1987 through late 1988.

The bottlenose dolphin research activities of the MMP can be grouped into three areas: 1) abundance estimation, 2) stock differentiation, and 3) stock productivity. The major goals of the abundance estimation work are to estimate abundance for establishing quotas for live-capture and to develop a time series database for trend analysis. The stock differentiation research is directed primarily at defining stock units for management of the live-capture fishery. Research on stock productivity has been directed at determining vital reproductive rates, with evaluation of the appropriateness of the 2% rule as a major goal. Numerous projects have been carried out to address these research goals.

In 1978, the MMP initiated research on census techniques (Leatherwood and Show 1980a) and based on the results of this research began a series of abundance surveys in localized areas, primarily areas where there was a demand for live-capture. During this same time, the MMP also initiated research on bottlenose dolphin local herd biodynamics, to develop tagging techniques and to address stock differentiation and productivity questions (Asper and Odell 1981, Odell and Asper 1982, Solangi and Dukes 1983).

The early work of the MMP was all directed at local populations of bottlenose dolphins, particularly in areas used by the live capture fishery. Beginning in 1982 and continuing into 1986, the MMP carried out regional surveys of the US Gulf of Mexico (Scott *et al.* 1989). These surveys were conducted seasonally and covered the waters from the shore (including embayments) out to 9.3km past the 186m (100 fathom) isobath. The primary goal of these surveys was to estimate abundance of bottlenose dolphins.

Site specific research has again become the primary focus of the MMP's bottlenose dolphin research. In addition to localized abundance surveys of the Mississippi Sound and the Chandeleur Sound (Mullin 1988; Lohoefener *et al.* in prep a, b), the MMP has established low-level monitoring studies in two sites: the Indian/Banana Rivers and the Sarasota/Tampa Bays. These studies examine trends in abundance and vital rates.

The bottlenose dolphin dieoff of 1987-88 required an emergency response from the MMP. As a result, planned research activities directed at assessing the status of Gulf of Mexico bottlenose dolphin stocks were halted. Several projects were conducted to investigate the causes and impacts of the dieoff, including: sampling surveys to address the

range and scope of the stranding event (Burn 1988); surveys and analysis of stranding data to assess the impact of the event (Scott and Burn 1988, Scott *et al.* 1988); collection and analysis of specimen materials for determination of stock structure and age structure (Hersh 1988a, 1988b); and support of the clinical investigation through carcass recovery, necropsy, and tissue sampling.

The MMP has conducted a limited amount of research on large whales. Most of the MMP's involvement with large whales has been through cooperative research with the Northeast Fisheries Center (NEFC), by providing staff for aerial survey work and for review of survey methods. The MMP has also been responsible for the development and implementation of a computerized system for the archival and analysis of photographs for the individual identification of right whales.

Funding for the MMP has totaled $2.96M over the 11 years of the research program (Figure 2). The highest single fiscal year (FY) funding level was $340K during FY85. The available funding for FY89 is $198K. However, $60K of this amount was held back from spending authority until the fourth quarter of the fiscal year in anticipation of the need to cover prior year NOAA deficits. The effect of this hold back may be to prevent the MMP from letting any planned contracts in FY89 since the contracting process normally takes more than one fiscal quarter

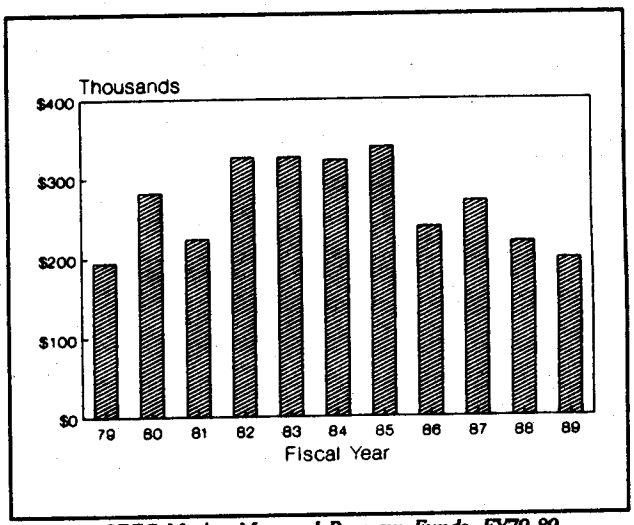

Figure 2. *SEFC Marine Mammal Program Funds, FY79-89.*

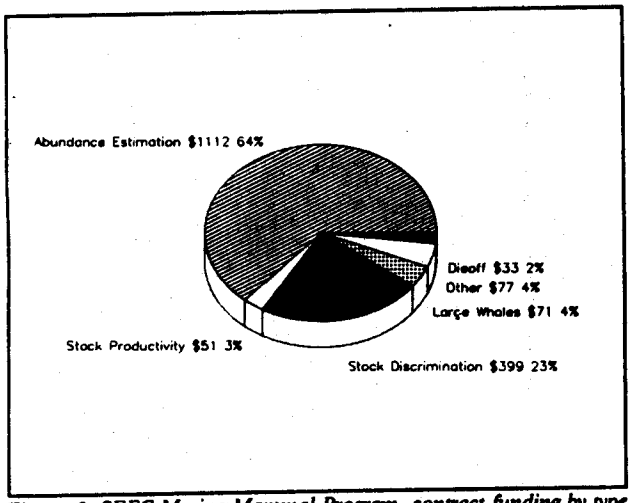

Figure 3. *SEFC Marine Mammal Program contract funding by type of research.*

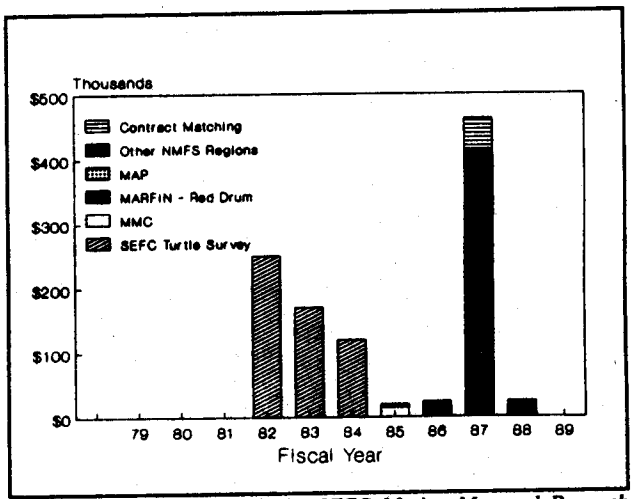

Figure 4. *Contributed funds for SEFC Marine Mammal Research Program, FY79-89.*

to complete. Assuming an average annual rate of inflation of 5% over the period 1979-1989, the FY89 MMP funding represents a 36% reduction in 1979 dollars from the initial FY79 funding level and a 52% reduction from the FY85 peak funding level. Overall, 59% of MMP funds have been used for contract research, 28% for personnel, 8% for inhouse research, and 5% for research related travel. Figure 3 shows the breakdown of contract funding by type of research, with the greatest amount spent on abundance estimation.

The MMP funding level does not reflect the total resources utilized for marine mammals. Information on marine mammals has been collected during surveys directed at non-marine mammal species. Limited amounts of outside funding have also been secured for specific marine mammal research projects. All together, contributed funds for specific marine mammal research and for projects which secondarily produced information on marine mammals totaled about $1.1M and came from a variety of sources, including: SEFC Endangered Species Funds, MMC, MARFIN, private industry and academic institutions, and other NMFS regions (Figure 4).

III. Issues

III.1. *National Management Issues*

The SEFC's MMP is involved with several priority issues of national concern: the bottlenose dolphin dieoff, the status of Gulf of Mexico bottlenose dolphins, and the protection and recovery of endangered right and humpback whales. A Congressional hearing on the dieoff concluded that there is a need for NMFS to conduct further research on the dieoff. The Southeast Fisheries Center will be required to verify its assessment of the impact on the affected dolphin population through additional data collection and analysis.

The status of the Gulf of Mexico bottlenose dolphins is also a priority because of recent concern from the environmental community regarding the continued effects of incidental take in fisheries and the take (by removal) of bottlenose dolphins for public display, research, or military purposes. The use of the 2% rule and the current quota system is being questioned. The MMC has suspended consideration of permit applications for removals until the MMC's concerns are addressed (see Appendix IV). The SEFC's MMP will be expected to address the MMC's and the environmental communities concerns in an expeditious manner.

The SEFC will also be expected to continue research as is required to promote the recovery of endangered right and humpback whales. These are considered priority species for which NMFS is currently developing recovery plans under the ESA.

III.2. *Marine Mammal Commission Critical Issues*

There are 4 critical issues for the MMC with which the SEFC's MMP is involved: 1) the bottlenose dolphin dieoff, 2) the live capture fishery and the 2% rule, 3) right whales, and 4) incidental take by fisheries and other sources, including oil and gas operations. The existing management regime for dolphin live-capture is based on the assumption that all stocks were at or near carrying capacity. This assumption was never tested, and OSP for these stocks was never determined. The questions the MMC has today are the same ones the MMC had in 1978 at the initiation of the MMP.

The MMC is also concerned with some other issues that involve the MMP. The question of inshore/offshore stock discreteness needs to be examined. Incidental take levels need to be determined and incorporated into quotas. Also, take for public display has not been random over age and sex class (it has been about 75% young females) and therefore may have affected productivity. These issues need to be addressed.

Another concern of the MMC is the decrease in available research funds for the MMP and the concomitant reduction in NMFS ability to meet its marine mammal research mandate in the southeast region. Funding for the SEFC's MMP was established as a NMFS line item in fiscal year 1979. The funding level has been fairly constant until recently, but actually has been decreasing in constant dollars due to inflation.

III.3. *Regional Management Issues*

The Southeast Regional Office (SERO) requires information on marine mammals for 2 major actions: 1) Section 7 consultations as required under the ESA, and 2) implementation of the MMPA and estimation of incidental take. The SERO also requires information on marine mammals for development and evaluation of fishery management plans as required by National Standards and Guidelines developed to facilitate implementation of the FCMA. Currently, our highest priority needs are for information on right whale abundance, calving areas, and migratory patterns in the southeast. Information on incidental take in fisheries is also a high priority. The major fisheries in the southeast (shrimp and menhaden) are presently classified as type III by legislation and do not require observers. There are indications of some level of take in longline fisheries (type II) and this may require placement of observers. Information on large whales and small cetaceans is required concerning the effects of oil rig removals on these species. The SERO also needs improved information on incidental take in fisheries other than those previously mentioned and looks to the SEFC to conduct necessary research to address this need.

Discussion of Items I, II, and III.

Comment: In the evolution of the 2% rule, it was noted that the IWC generally assumed that the net annual increment of exploited whale stocks was at least four percent and, consequently, that limiting the annual take to two percent of the minimum estimated population size would insure that the affected populations were not reduced below their maximum net productivity levels, provided they were at or above that level when the management program was initiated and there were no additional sources of non-natural mortality.

Response: The assumption of bottlenose dolphin population size being at or near carrying capacity is a legal question. The 2% rule is a biological assumption, and when it was framed, it was constructed with a built-in safeguard. That is, 2% is not assumed to represent the maximum per capita population growth rate, or intrinsic rate of growth, which occurs at very low population levels, but is assumed to conservatively represent the population maximum net productivity in absolute numbers of animals. Based on our current belief of the dynamics of large mammal populations, long-term removals at a rate equivalent to or less than 2% are not expected to result in population levels outside of the OSP range. The 2% should, however, include all mortality other than natural, such as fishery by-catch, other forms of human-induced mortality and removals for live-capture.

Question: Why do we need live-capture? Can't the needs for display and research animals be meet by captive breeding?

Response: At Sea World, more and more bottlenose dolphins are coming from captive breeding programs, but the feeling within the industry is that we still need wild dolphins. There would be many problems with genetic management, because the captive population is too small to maintain viable genetic variability. Therefore, there will always be a need for wild genetic input.

Comment: There is increasing pressure for captive breeding and cessation of live-capture, especially from environmental concerns.

Comment: Economics may be a reason there is not more captive breeding. It probably is still cheaper to capture animals than to buy captive bred animals from an organization like Sea World. If capture were banned, breeders could control the market.

Comment: The present rate of captive births at Sea World would not generally be high enough to provide any extra dolphins to sell to outside concerns.

Comment: Military demands for dolphins would probably not be met by captive breeding. Given the genetic management concerns and military demand, it seems unlikely that, in the short-term at least, demand for animals could be met by captive breeding.

Question: It is apparent that SEFC research funding for marine mammals has dropped precipitously in the last few years. It is unclear to what happened to these funds. For instance, the SEFC current year operating plan for fiscal year 1989 started with $408K at the Miami Laboratory for protected species research, yet the material presented here puts the current funding level at $198K. What has happened to the balance of these funds?

Response: The $408K in the current year operating plans includes research funds for both marine mammals and turtles at the Miami Laboratory. The Miami Laboratory funds for turtles represents only a portion of the total SEFC resources put toward turtles. On the other hand, the Miami Laboratory funds for marine mammals represents all of the current SEFC funds for marine mammals. The funding available for marine mammals at the Miami Laboratory at the beginning of the fiscal year, on 1 October 1988, was $213K. Because a substantial part of the marine mammal research funds have been used for outside contracts, these funds become subject to sometimes disproportionate reductions, given the policy of minimizing the impact of budget reductions on permanent staff. In fiscal year 1989, however, the marine mammal research funds were finally reduced by $15K. However, an additional $60K was held back to contribute to the National Weather Service shortfall. This amount was finally authorized for expenditure in the fourth quarter of the fiscal year. It is not yet clear if we will be able to put these funds toward new site-specific monitoring research due to the length of time the contracting process takes. As with other research activities at the SEFC and Miami Laboratory, the available research dollars continue to decline while the unresolved research issues seem to escalate.

Comment: Since there is a relatively large military demand for these animals that is not likely to be met by captive breeding, and since there are still some issues relating to allowable levels of take for dolphins requiring research for which NMFS funding is insufficient, it seems prudent to have the Navy fund research that relates to live-capture issues. It also seems prudent to require an agency such as Minerals Management Service (MMS) to fund research if activities for which they have oversight responsibility might adversely impact marine mammal populations in the region.

Comment: MMS has issued a request for proposals (RFP) for right whale surveys from Florida to Georgia. There is a MMS-sponsored workshop in Louisiana in August, 1989, that is intended to identify agencies' responsibilities and concerns relative to offshore oil development in the Gulf. The Environmental Protection Agency (EPA) is starting a program on marine mammals and contaminants. NMFS and the SEFC should be involved with the research directions of all these activities.

Comment: One of the most important issues identified is that of evaluating bycatch in fisheries. Although we have insufficient information at present to fully estimate these bycatch rates, there is an action that could be taken that I believe would likely reduce these rates. That is, full implementation of the turtle excluder device (TED) regulations. I think the MMC should join with NMFS in calling for enforcing TED regulations. This would help stop incidental take.

Question: There is another issue regarding the classification of the coastal migratory stock as depleted. Is NMFS proceeding forward with a depletion action?

Response: NMFS is proceeding with a depletion notification based on the SEFC's assessment of the possible impact on the affected dolphin stock from the information at hand. The proposed depletion classification was sent for review to all of the NMFS Regions and Centers and, after incorporating the review comments into the depletion notification, the proposal for classifying this stock as depleted is being carried forward.

IV. Research Presentations: Bottlenose Dolphins

IV.1. *Stock Differentiation Research*

The stock differentiation research was undertaken as a result of recommendations by the MMC, outside experts, and other NMFS offices during review and planning meetings of the late 70's and early 80's. Initially, inshore stocks of bottlenose dolphins were thought to be local, resident, and possibly reproductively isolated. The resident stocks were thought to share a common gene pool distinct from transients and other resident stocks. As a result, there was general concern that the live-capture fishery might result in over-exploitation of local, resident stocks. Therefore, the stock differentiation research was needed to define the stock units to evaluate the impact of removal on the stocks. The SEFC has supported several research approaches to address this question, including: biochemical genetics studies, resightings of individuals, and morphometry studies.

The first projects to address stock differentiation were the local herd biodynamics contract studies of the Indian/Banana Rivers and the Mississippi Sound (Asper and Odell 1981, Odell and Asper 1982, Solangi and Dukes 1983). During these studies, animals were captured, tagged, sampled, and released. The studies included biochemical genetics, resightings, and morphometry. The genetics work indicated that there was evidence of local stock differentiation, but also evidence of genetic exchange. The resighting work in the Indian/Banana Rivers provided evidence that the stock was resident, and none of the tagged animals have ever been seen outside of the river system. The morphometry work showed that there were differences between the Indian/Banana and Mississippi animals, but they may just have been clinal differences, although these too could have management implications.

Another contract was issued in 1984 to study the genetic variability of bottlenose dolphins in captivity (Duffield 1987). The dolphins sampled were taken from a variety of geographic locations along the southeastern US and from the Pacific. This study compared allelic frequencies and levels of heterozygosity based on electrophoretic analyses of serum and red blood cell proteins for bottlenose dolphins representative of capture sites extending along the Atlantic coast of Florida, through the Florida Keys, to the Gulf of Mexico and in the Pacific, from southern California through the Gulf of California. There were no discrete allelic differences between any of the collection sites. Allele frequency and genotypic profile differences provide some evidence for local subpopulation differentiation, however there is evidence, as well, for gene flow between collection areas. Adequate biochemical variability exists in bottlenose dolphins to make this approach a useful tool for examination of the pattern of local area use by bottlenose dolphin herds and for the detection of reproductive exchanges between these groups. The author of the study concluded that increased sampling would allow estimation of the rates of genetic exchange between localized groups of dolphins.

The SEFC also provided partial support in 1986 for studies of bottlenose dolphins in and around Sarasota Bay, Florida (Duffield and Wells 1987, Wells 1987). The funding was for a summary report of research which addressed the question of stock differentiation. The research included biochemical genetics and behavioral studies. The genetics work examined the genetic relationships within and between population units defined by resighting surveys. Genetic differences were found which correlated with the behavioral community designations. However, strong genetic heterozygosity within the Sarasota community indicated that it was not a closed reproductive unit.

Electrophoretic hemoglobin profiles have also been used in work supported partially or fully by the SEFC to differentiate bottlenose dolphin stocks. Dolphins of shallow water stocks have a single electrophoretic form (100% fast) while dolphins believed to be of deep water stocks have a double form (30% fast, 70% slow). This differentiation is also supported by differences in the morphometry of these stocks (Hersh 1987, 1988a).

IV.1.1. *Herd Biodynamics Studies*

IV.1.1.1 *Indian/Banana River*

The herd biodynamics work in the Indian/Banana River area of Florida was supported by the SEFC under three contracts. Sea World was issued two contracts for capturing, tagging, sampling and resighting work during 1979-81. Another contract was issued to Mote Marine Laboratory for resighting surveys for the marked animals during 1980. Other work was also done independently by Sea World. The research was initiated in the fall of 1979 with the capture, tagging (by freeze brand), and release of 25 dolphins. The objectives of this first study were to test the use of freeze branding for resighting work and to examine movements of tagged animals. Later work was primarily to determine the stock discreteness of this population unit.

During the first study and subsequent work, animals were captured using two boats and one long net. Herds of 4-5 animals were captured by encirclement with the net. Animals were removed from the net and placed aboard the boats for processing. During processing, the dolphins were kept wet and samples (morphometrics, blood, cultures, etc) were taken. Photographs were taken of flukes, flippers, and dorsal fins. Freeze brands were placed on both sides of the dorsal fin and on both sides of the dorsal surface under the dorsal fin. Most animals also had a tooth taken for aging, and were also injected with tetracycline for a tooth time marker. A total of 75 dolphins were tagged under contract; approximately another 50 were tagged independently by Sea World. The tagging sample was biased as capture of herds with calves was not allowed, resulting in twice as many males as females being tagged.

During the second and third years of the study, many of the tagged animals were recaptured. The freeze brands showed varying degrees of repigmentation, but all were still legible. The brands last as far as known at least up to 10 years. Tagged animals are still being resighted.

The resighting work indicates that the dolphins are resident to the Indian/Banana River system. About 95% of the tagged animals have been resighted, and all resightings (from dedicated surveys and from other sources) have been within the system. All of the tagged animals that have stranded (12) have been recovered with the system.

The genetics work suggests that stock may be distinct but with north/south components of the population. Hemoglobin profiles were all of the fast, coastal type. A confusing factor is an apparent increase in the population during the summer. This is either because of immigration or redistribution of residents. Redistribution could occur in response to redistribution of prey species.

IV.1.1.2. *Mississippi Sound*

The purpose of this study was to (1) collect, mark, obtain biological data from and release 50 Atlantic bottlenose dolphins in the Mississippi Sound and (2) to establish a database for blood chemistry, microbiology, age, genetics, endocrinology, and morphometrics for dolphins inhabiting the Sound. A total of 20 males and 33 females were capture and processed in 1982 during the course of this study. An additional 4 animals were marked and released into the Mississippi Sound in 1983. This work was conducted under contract for the SEFC by Marine Animal Productions.

Samples were taken from several sites (blowhole, anus, blood, and vagina) on 50 of the bottlenose dolphins. At least 40 different species of bacteria were isolated. At least 5 different species of yeast and several unidentified species of mold were isolated. The organisms isolated were generally consistent with what would be expected in marine mammals from the Gulf of Mexico. The array of isolates was somewhat different from that of dolphins sampled previously in the Indian River, Florida.

Resighting surveys in Mississippi Sound were conducted from 1982-1985 by SEFC scientists. During this period of sampling 42 of 57 marked dolphins were resighted in the Mississippi Sound (Lohoefener *et al.*, in prep. a). Only 5 of the marked dolphins were resighted frequently enough to allow speculation on whether they had home ranges in Mississippi Sound. Four of these dolphins

appeared to prefer very specific areas of the Sound during the warm months of the year.

IV.1.2. *Behavioral Indices*

Studies of the Sarasota area bottlenose dolphin population began in 1970 and have been ongoing since. This work was initiated by A.B. Irvine in the early 1970's, and has continued under the direction of R.S. Wells through the offices of Dolphin Biology Research Associates, Inc. Funding for this work has come from a variety of sources, including major contributions for fieldwork from Earthwatch and minor contributions for data summarizations and report preparation from the SEFC. The studies were started with the tagging of dolphins captured by commercial collectors but deemed unsuitable for removal. These and other marked dolphins were observed during resighting surveys. Later, during 1975-76, radio transmitters were placed on 10 dolphins for the purpose of tracking movements. Another capture program was started in 1984 and continues to date. In this capture program, all animals are released after marking and biological sampling. The dolphin population also has been photographically sampled to document naturally marked animals. The photo catalogue contains some 500 individuals (both naturally marked and tagged) documented to occur in and/or near the Sarasota area. The main purposes of the studies have been to examine site fidelity, unit discreteness, and the population structure, and also to determine vital rates.

The radio tracking and resighting studies in and around Sarasota Bay have shown that there is a considerable stability in home range patterns. The animals exhibit a year round home range with seasonal distribution patterns within the range. The dolphins occur more in passes and inlets in winter and more in shallow areas in summer. These distribution patterns can be related to the distribution of dolphin prey and predators.

The studies also show that the Sarasota area dolphin population consists of three main discrete units: 1) Sarasota, 2) nearshore Gulf of Mexico, and 3) Tampa Bay. There is some mixing between the three areas. Biochemical genetics indicate that there is more heterozygosity than would be expected with a community of this size, therefore outbreeding must occur. The accumulation of new individuals in the photo catalogue slowed rapidly, and this indicates that the Sarasota population is nearly wholly identified.

The main sub-units of the population are female bands. These groups are made up of related and unrelated mature females. These dolphins form groups of up to 10-15 adults plus their most recent calves, are frequently found together and share the same range. The females calve at intervals of 3-6 years. When a female has a

new calf, the old calf leaves the female band to join a sub-adult group. Females return to mother's band when mature. Adult females are resighted twice as often as adult males. Males form long-term pairs as they mature, and travel between female bands. Males also begin moving outside of the Sarasota community when mature. The males may be the mechanism for genetic exchange between populations.

Between 25 and 40 dolphins have been removed from waters between northern Charlotte Harbor and southern Tampa Bay area, in and around the Sarasota Bay study area for public display or research. The last known removals of dolphins from the Sarasota area occurred in 1975.

Discussion of Stock Differentiation Studies

Comment: Females may be more resident than males, which could impact on stock identification work. Perhaps the reason females of a size class are taken by live-capture interests in greater percentage is because they are more resident. Also, perhaps we should see if the Navy has done any blood work with the bottlenose dolphins it uses for deep diving work. The hemoglobin of these animals should be examined in regard to the fast or slow electrophoretic hemoglobin profile.
Response: Although females may be more resident than males in areas like Sarasota Bay, there is also an industry preference for young females. There are skull characteristics that correlate with the hemoglobin types, lending support to the hypothesis of stock differences as indexed by hemoglobin type. Dr. Duffield has worked with Dr. Ridgway from the Naval Oceans Systems Center in San Diego in analysis of hemoglobin and of blood protein isozymes and presumably had access to specimens from animals that the Navy holds.
Comment: There is a preference for young females by live-capture concerns. The reason(s) for this preference are not clear to me.
Question: What percentage of animals have been tagged in the Indian/Banana River population?
Response: Based on estimates of abundance, between 25-50% of the Indian River dolphins have been tagged.
Question: Were there any significant sex-age class differences during resighting surveys of the Indian/Banana River dolphins?
Response: No differences in sex-age class observations were obvious in surveys of the Indian/Banana River.
Question: Was there any difference in brand retention of Indian River dolphins due to sex of the animal?
Response: None was observed.
Question: In the Mississippi Sound tag and resight studies have a large percentage of resightings been made outside of the Sound?
Response: Dr. Solangi of Marine Animal Productions, the major dolphin collector in the northern Gulf, has said that more than 60% of the reported resightings have been made outside of Mississippi Sound. This information is based on volunteer reports from up and down the Gulf coast. NMFS survey data shows that approximately 74% of the dolphins tagged in the Sound were knowingly resighted in the Sound.
Question: Are the dolphin male/female interactions in the Sarasota Bay study area seasonal?
Response: There is a peak in calving in May/June/July, and a lower peak during Sept/Oct.
Question: Concerning the resighting surveys in Sarasota Bay, were the surveys systematic or opportunistic?
Response: The surveys were systematic with the boats following pre-determined routes. The routes were determined largely by water depth, since much of the area outside of channels is too shallow for boat traffic.
Question: What percent of the dolphin population is actually in the area of Sarasota Bay at anytime?
Response: The answer to this question depends in large part on how Sarasota Bay is defined. The nautical charts consider the Bay to be limited to waters east of Lido and Longboat Keys. Typically less than 1/3 of the population is in these waters at any given time. The home range of the Sarasota residents also includes Anna Maria Sound, Palma Sola Bay, Manatee River, Terra Ceia Bay, coastal Gulf waters, and southern Tampa Bay. Thus, Sarasota dolphins include other quota areas in their typical movement patterns.

IV.2. *Review of Localized Surveys*

The localized abundance research was recommended during review and planning meetings with the MMC, outside experts, and other NMFS offices during the late 70's and early 80's. Bottlenose dolphin abundance estimates were needed to set quotas for

localized areas were there was a demand for live-capture. A methodology development study was initiated in 1978 and completed in 1978. Regular seasonal surveys of the localized areas were implemented in 1979 and completed in 1983. The methodology development and the regular seasonal surveys were conducted under contracts for the SEFC. The analysis of local survey data and abundance estimates for critical areas were completed by SEFC scientists by 1983 (Thompson 1981a,b,c, 1982a,b), and the rest of the estimates were completed recently (Hansen and Scott 1989).

The methodology development study was completed under contract by Hubbs/Sea World Research Institute (see Leatherwood and Reeves 1983; Leatherwood, Reeves and Show 1982; Leatherwood and Show 1980a,b; Leatherwood *et al.* 1982; Leatherwood, Swartz and Jones 1979). Aerial surveys using line-transect survey techniques had been chosen as the sampling method. The development study was designed to: 1) evaluate statistical models use to estimate density 2) test four different survey altitudes, and 3) compare the aerial survey results with vessel surveys. Surveys were conducted off Tampa, Florida; in Indian and Banana Rivers, Florida; and off south Texas.

Five statistical models were applied to data from each area and season to produce density and population estimates of bottlenose dolphins. Based on numerous considerations, primarily the fit of the measured sighting distance distributions to the required theoretical models and the biological "reasonableness" of the estimates, the most appropriate model was selected for each area. It was recommended that an appropriate model should be selected independently for each data set.

Of four altitudes tested (500, 750, 1000, and 1250 feet), flights at 750 feet resulted in higher numbers of sightings and estimates of total population. No significant effect of altitude could be demonstrated on herd size, age composition, or sighting distance. It was recommended that the following surveys be conducted at about 750 feet.

The results of the aerial and vessel survey comparisons indicated to the authors that the vessel surveys over-estimated population size. It was believed that the dolphins were attracted to the vessel, thereby positively biasing the estimates. Another source of bias concerned the sampling capabilities of the vessels. The vessels sampled a much smaller area than the aircraft, which could result in a strong negative or positive bias depending on the distribution patterns of the dolphins in relation to the area sampled. The aircraft could also provide much more coverage of a given area at a lower cost. Therefore, aerial surveys were recommended over vessel surveys.

The regular seasonal survey, or data collection phase, involved the sampling of the following 9 areas of the US southeastern waters: 1) Aransas, Copano and San Antonio Bays, TX; 2) Houma (Terrebonne and Timbalier Bays) LA; 3) Mississippi Sound, MS; 4) Destin (Pensacola and Choctawhatchee Bays), FL; 5) Apalachicola and St. Joseph

Bays, FL; 6) Charlotte Harbor, FL; 7) Key West, FL; 8) Indian/Banana Rivers, FL; 9) Savannah (Port Royal and St. Helens Sounds) GA and SC. Six flights were conducted in each area during each season. These data collection services were conducted by MAR, Inc. under contract for the SEFC.

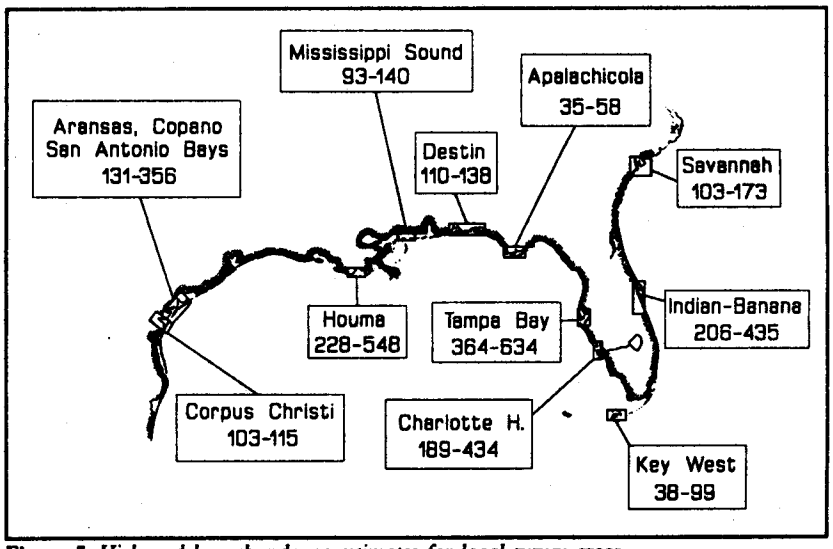

Figure 5. *High and low abundance estimates for local survey areas.*

The analyses of the survey results were conducted in house (Thompson 1981b,c, 1982a; Hansen and Scott 1989). Figure 5 shows the high and low abundance estimates for each area. Seasonal differences were evident in the following areas: 1) Aransas, Copano, and San Antonio Bays with a fairly definite spring low; 2) Houma with a winter low and a spring high; 3) Charlotte Harbor with a winter high; and 4) Indian/Banana Rivers with a summer high.

IV.3. *Review of Mississippi Sound Abundance Estimates*

The Mississippi Sound is a shallow sound in the northeastern Gulf of Mexico, about 110 kilometers (km) long and separated from the Gulf of Mexico by barrier islands 20 to 40 km from the mainland. The total surface area is about 1,580km^2. The bottlenose dolphin live-capture industry removing dolphins from the Mississippi Sound has been the largest in the United States. From 1973 through 1988, 202 bottlenose dolphins were reported as permanently removed. Monthly, from October 1984 to October 1986, the abundance of bottlenose dolphins in the sound was studied by SEFC scientists with some support from the MMC (Lohoefener *et al.*, in prep. b) by conducting line transect surveys with a small boat.

The density of bottlenose dolphin herds varied seasonally. Herd density was lowest during the winter and greatest in late summer and early fall. When extrapolated to the 1,580km^2 study area, density of dolphin herds was estimated to range between winter lows of 100 to 200 herds, and summer and early fall highs of 300 to 400 herds.

As a product of herd size and herd density, estimated adult dolphin density showed the same cycle. Adult dolphin density was estimated to vary from winter lows between 0.2 and 0.3 dolphins/km^2 to summer highs of 1.0 to 1.4 dolphins/km^2. When

extrapolated to the Mississippi Sound study area, numbers were estimated to range from 400 to 2,100 adult dolphins, depending on the season.

The abundance of bottlenose dolphins in the Mississippi Sound was found to be seasonally cyclic with winter lows and summer and early fall highs, possibly in response to prey availability. The sound is shallow and its waters become cold in the winter. Many species of fish are known to leave the sound during the winter months. Shrimp trawling activities usually start in the spring and continue into the fall. Dolphin herds are often observed associated with trawlers, and shrimp trawling may attract dolphins into the sound.

Studies also were undertaken by SEFC with support from the MMC (Lohoefener *et al.* in prep. b) in response to the proposed removal of 30 dolphins from the Sound for the Navy. In 1982 and 1983, 57 adult bottlenose dolphins (2:1 females) were marked with freeze brands. From August 1982 through September 1985, a marked dolphin resighting study was conducted in the Sound. During the spring and summer of 1984, a commercial dolphin capture interest removed 30 adult dolphins from the Sound. The resighting data were used to test whether the dolphin removal could be detected in the population and whether the removal caused a detectable change in the behavior of the marked dolphins. It was concluded that the study violated too many assumptions associated with mark and recapture experiments for a reliable population estimate. Given the extreme variability of the data, a removal of about 1,500 dolphins would have been necessary before this study could have detected the removal.

Discussion

Question: Where do Mississippi Sound animals go during the low abundance season?
Response: Information indicates that the density of dolphins increases during the winter just outside of the barrier islands. These may be animals that move out of the Sound in winter.
Question: Are dolphins attracted to the survey boats? Is this a source of bias in the estimates?
Response: The dolphins do not appear to be attracted to the survey boats, based on about 120 observation of small boats with dolphin herds nearby. In nearly all these observations, herds were apparently neither attracted nor repelled by the boats. However, these observations may give false impression since they are made from the same type of platform to which we hypothesize the animals are insensitive.
Question: There may be some other undetected sources of positive bias in the small boat estimates of abundance. For instance, small errors in distance measurements could result in bias in abundance estimates. Also estimates of average herd size could be much larger than the population average if larger herds are easier to see than small herds, this too would result in bias in abundance estimates. Was the recycling rate on your LORAN set fast enough to make the small distance measures you used?
Response: The LORAN recycled fast enough to make the distance measures that were used. No evidence of large size-bias was found in our estimates of average herd size.

IV.4. *Review of Chandeleur Sound Abundance Estimates*

Three adjacent bottlenose dolphin habitats (salt marsh, shallow sound, and Gulf of Mexico) in southeastern Louisiana were sampled for one year during 1985 and 1986 from a high-winged aircraft by SEFC scientists with some support from Marine Animal

Productions (Mullin 1988). Line transect methods were used to estimate seasonal herd densities for each habitat. Seasonal dolphin density for each habitat was estimated as the product of herd density and mean herd size. Herd densities ranged from 0.026 to 0.091 herds/km^2 with densities usually greatest in the marsh and least in the gulf. Ranges in mean herd sizes were: gulf, 6.4 to 14.6; sound, 5.1 to 8.1 ; and marsh, 3.7 to 5.4. Except for spring, dolphin densities were largest in the gulf (0.35 to 0.58 dolphins/km2) and smallest in marsh (0.16 to 0.36) within each season. Spring dolphin densities were generally similar among habitats. Dolphin herds were distributed throughout all habitats surveyed each season. Although herds seemed to be less common in the mid-sound habitat, dolphin herds were found in almost every portion of the study area. The distribution of herds within each habitat did not appear to change seasonally.

Within each season, mean herd sizes were largest in the gulf and smallest in the marsh. Mean herd sizes from the marsh and sound showed little seasonal variation. Summer and fall herd size estimates for the gulf were much larger than those from the winter and spring. Except in winter, when the pattern is reversed, herds were respectively most dense in the marsh, sound and gulf. In all habitats and seasons the smallest herd densities occurred in summer.

Estimates of dolphin density were possibly negatively biased. Because the transect line was not visible from the aircraft, left truncated sighting distributions were used to estimate the effective swath width and this estimate was possibly biased low (Alldredge and Gates 1985). Since herd sizes were generally small (<10 dolphins), some herds may have been missed because the entire herd was submerged and not visible.

Within each habitat type, dolphin density appeared to be seasonally variable. Also, the density of dolphins was greater in the gulf habitat than the more inshore habitats. Except for summer, the total estimated number of dolphins in the study area was generally similar for each season (spring, 1,022 dolphins; summer, 618; fall, 917; winter, 838; 2nd spring, 959).

IV.5. *Review of Regional Surveys Abundance Estimates*

In response to MMP plans developed in 1978, and the Stock Assessment Workshop of 1982 and 1983 MMC recommendations, a regional sampling survey design was implemented by the SEFC (Scott *et al.* 1989). The objective of the survey design was to provide a regional baseline data set for estimating region-wide bottlenose dolphin abundance and to provide a basis for detection of trends in abundance and distribution patterns. The sampling design incorporated features for replication of prior sampling survey study areas (e.g., the localized surveys) to the degree possible and for relatively high effort in areas of live-capture fishery operations to obtain reasonably precise

estimates. The chosen sampling platform, a twin-engine Beechcraft D-18S with a nose observation blister modified to accommodate two observers, allowed unrestricted forward and downward visibility of transects to avoid the difficulties of left-truncated sighting distributions.

Seasonal sampling surveys of the US Gulf of Mexico waters were conducted between September, 1983 and February, 1986. Sampling of the northwestern Gulf started in 1983 and was completed in 1984. All 4 seasonal surveys of the northwestern Gulf were completed. Sampling of the northeastern Gulf started in 1985 and was finished in 1986. Only 3 of the 4 seasonal surveys were completed (spring survey missing). The survey areas were stratified by depth zones into 3 categories: Bay, Inshore (both <18.3m), and Offshore (18.3-183m). Some survey areas were also stratified to match with prior sampling areas. The study surface area totalled some 359,000km^2. Overall, about 103,490km of transect lines were flown. A total of 13,225 bottlenose dolphins comprising 1,986 herds were observed. This data collection task was completed by Aero Eco Services, Inc. and Biological Surveys, Inc. under contract.

The data were analyzed by SEFC scientists using line transect theory. The sensitivities of the components of the estimator to variable survey conditions were examined in various ways. The density of bottlenose dolphins was estimated as the product of:

- f(0) - sighting PDF (probability distance function) at trackline
- g - average herd size
- n/2L - sighting rate (n = number sighted, L = line length)
- a - bias adjustment term for environmental effects

The sighting PDF was modeled with the Hermite polynomial method (Buckland 1985). Bootstrap estimates were obtained from 1000 replicate fits per analytical stratum. The estimates of f(0) were found to be sensitive to herd size class (size bias) and glare (environmental effect). The size bias was controlled by stratification over herd size classes.

Small herd size estimates were found to be sensitive to environmental sighting conditions, but insensitive to variations in season or depth. The glare effect predominated in the small herd size class (1-2 dolphins/herd). Small herd size estimates were found to be 7% larger in "poor" conditions and were adjusted accordingly. Medium herd size estimates were not sensitive to environmental sighting conditions, depth, or seasonal variations. The large herd size estimates were found to be sensitive to variations in depth, but insensitive to season or environmental sighting conditions. This variability by depth was attributed to population variation since herd size has consistently been found to increase with distance from shore. Thus, depth-stratum specific estimates of large herd size were used.

The sensitivity of the sighting rate (n/2L) for each herd size class to sighting conditions was examined using data from 4 test areas. The 4 test areas all had adequate numbers of sightings to allow for the examination of the effects of the sighting conditions. The sighting rates of large and medium herds were found to be insensitive to variations in sighting condition. Small herd sighting rates were lower in "poor" conditions and were adjusted accordingly.

The estimates of density and abundance for defined and proposed management areas were relatively precise with coefficients of variation of approximately 20%. The region-wide estimates of abundance suggest that the northeastern Gulf supports a larger population than the northwestern Gulf. Estimates of surface abundance suggest that, on average, and assuming no net movement between areas, approximately 35,000 to 45,000 bottlenose dolphins may live in the US Gulf of Mexico waters of 183m or less. Although the estimates have been adjusted for observed effects of survey conditions, the estimates are likely conservative to an unknown degree due to diving behavior.

Discussion

Comment: Comparisons between aerial and small vessel surveys in the Mississippi Sound have been made. Data from 3 replicate surveys with both aircraft and a small boat were obtained. The aircraft samples were taken in a single day while the vessel samples were taken over several days, close to, but not necessarily the same as the aircraft during each of the 3 sampling periods. The aircraft used were high-wing, side-viewing; 2 samples were taken from an aircraft with retractable gear while the third was with an aircraft with fixed gear. The surface vessel used was the same as described by Lohoefener et al. (in prep b.) and discussed previously. The retractable gear aircraft estimates were the same as the vessel, data from the fixed gear aircraft resulted in an estimate much lower than the small boat.
Question: What about water clarity? Could water clarity have an effect on estimates?
Response: Yes, water clarity could have an effect, depending on depth or other factors. Water clarity is a factor that relates to the more general problem of estimating the proportion of time a pod of dolphins spends at or near the surface and is available to be seen from various platforms. Estimating this variable in study areas like the Mississippi Sound and elsewhere, using an independent sampling method, could help resolve the reasons for the sometimes large differences between surface vessels and aircraft.
Comment: The 2% rule used to be, or was meant to be applied to the lowest seasonal count.
Response: The quota recommendations that have been made are based on the estimated low period abundance level. That is taken as an the low season point estimate if it is different at an approximate 95% probability level from the other seasonal estimates, otherwise it is taken as the average of the seasonal estimates.

IV.6. *Review of Chandeleur Sound Model*

A two stage model was constructed by SEFC staff (Mullin 1988) in order to relate the fraction of noncalf dolphins accompanied by calves (*i.e.*, dolphin < 1 year of age) observed annually (AFC) in a population to ranges in values of specific population parameters. The first stage was a modified extension of a general delphinid model proposed by Reilly and Barlow (1986). They calculated the finite rates of increase that could result from all combinations of all reasonable discreet values of the population parameters: (1) calving interval, (2) age of first birth, (3) calf survival rate, and (4) noncalf survival rate. Using the Lotka equations (Eberhardt 1985) and assuming an

even sex ratio and a stable age distribution, the annual pregnancy rate (fraction reproductive females pregnant) and age structure (calves, immature, reproductive and post-reproductive) associated with each parameter combination were calculated. Pregnancy rate and age structure were used to calculated what fraction of the total population would be pregnant annually (AFP).

The second stage of the model was constructed to estimate the AFP from AFC data in an observed dolphin population. The AFC will be negatively biased by calves not being recognized because of growth, and the distribution and level of calf mortality (including failed pregnancies).

Mature female bottlenose dolphins are typically about 250 cm in length and calves are about 100 cm at birth (Harrison *et al.* 1972, Sergeant *et al.* 1973). A dolphin was defined as a calf if it was associated with a dolphin which was about twice as large. Little is known about the growth rate of bottlenose dolphin calves. However, spotted dolphin, *Stenella attenuata*, calves growth about 50% in length by 1 yr of age (Hohn and Hammond 1985). If this was true for bottlenose dolphins, calf dolphins would be classified as noncalf after about 6 months and the number of calves would be underestimated by a factor of 2. To correct for calf mortality, it was assumed that all mortality occurred before or shortly after birth (i.e. , all calves observed lived to be 1 yr old). The fraction of the observed population which was pregnant annually (AFP_o) was estimated as

$$AFP_o = 2\ [AFC/(1\text{-}AFC)\ ]/CSR$$

where CSR was the calf survival rate.

The first stage of the model revealed that the AFP could range from 0.05 to 0.16 in a population. The calving interval had the greatest effect on AFP; AFP greater than 0.09 only occurred if the calving interval was 2 or 3 yr and values less than 0.07 resulted if the interval was 4 or 5 yr. Any value of age of first reproduction could be associated with any AFP less than 0.12 given the proper combination of other parameters. Any AFP was possible through the entire range of calf survival and noncalf survival rates. Finite rates of increase ranged from 0.87 to 1.10. Modeled populations could be stable, increasing or declining at any level of reproduction. The noncalf survival rate had to be 0.90 or greater for a stable or growing population. The age structure of modeled populations varied: calves, 4 to 13%; immature, 31 to 43% ; reproductive, 43 to 54% ; and post- reproductive, 1 to 10%.

The AFC for a north-central Gulf of Mexico study area was 0.03. Using the range of possible calf survival rates (0.50 to 0.94) the AFP_o could range from 0.03 to 0.12. For this range of values, the population growth rate could be positive, negative or

stable. The calving interval, noncalf survival rate and age of first birth could be any within the range of reasonable values.

Without some additional knowledge of either age structure, growth rate or the other population parameters, knowledge of the AFC in a bottlenose dolphin population does not provide much insight into population dynamics unless the AFP exceeds 0.12. A specific CSR estimate is needed to focus the model in its present form. Without a CSR estimate, the range in the predicted AFP is too broad to be useful.

The most important aspect of the model is that the number of calves in a bottlenose dolphin population is not good indicator of the population's status. A population can be growing given extremely low reproduction or declining given high reproduction.

IV.7. *Surveys for Turtles and Oil Rigs*

Aerial surveys are being conducted offshore of Louisiana to determine the spatial relationships of marine turtles to oil rigs. These surveys are being conducted by SEFC scientists under contract for the Minerals Management Service. Sea turtles are the primary targets of the surveys, but records also are kept of all marine mammal sightings. Bottlenose dolphins are the most frequently seen cetacean, with spotted dolphins (*Stenella plagidon*) the second most. Sperm whales (*Physeter catadon*) and beaked whales (*Mesoplodon* sp.) also have been observed.

There are five study areas, selected for having significant amounts of area with and without oil platforms. The study areas also have similar amounts and types of habitat (part deep, part shallow, etc) distributed throughout the areas of with and without oil rigs. A National Oceanic and Atmospheric Administration Twin Otter aircraft is being used for the surveys. This aircraft has side-mounted bubble windows which allow a relatively unobstructed view forward and beneath the aircraft as well as to the side and rear. A high resolution video camera, mounted in the belly of the aircraft, is used to monitor the trackline.

The herd density of bottlenose dolphins is less in deep waters areas, as is the estimated total abundance. Data collected on the association of dolphins to the oil platforms suggests that dolphins may avoid the platforms.

Discussion

Question: During your surveys do you record observations of plastics or other debris?
Response: Yes. Five gallon plastic bucket lids and other plastic floatablesare commonly observed at the surface. Sizes and positions of oil slicks in the study areas are also recorded. Based on these observations, the amount of oil spilled in the study areas overall may be larger than that from the Exxon Valdez.

IV.8. *Review of Quota Recommendations*

In the Southeastern Region, the live-capture fishery is managed under the 2% quota rule. The annual quotas for live-capture and removal are taken as 2% of the estimated local stock abundance level in a given management area. The management areas have been defined on the basis of historical regions of live-capture and on knowledge of local stock abundance in other areas.

Several assumptions have been made concerning this management regime. First maximum net productivity (MNP) for bottlenose dolphins has been assumed to be within the range of 2-6% based on analogy with other species. The value of 2% has been assumed to be conservative and has been used in the absence of an accepted MNP estimate from a particular stock. Each management area or subarea has been assumed to represent a unit stock. The unit stock is the resident dolphin population and the seasonal low abundance is assumed to be the resident stock abundance. It also has been assumed that estimates of abundance are accurate.

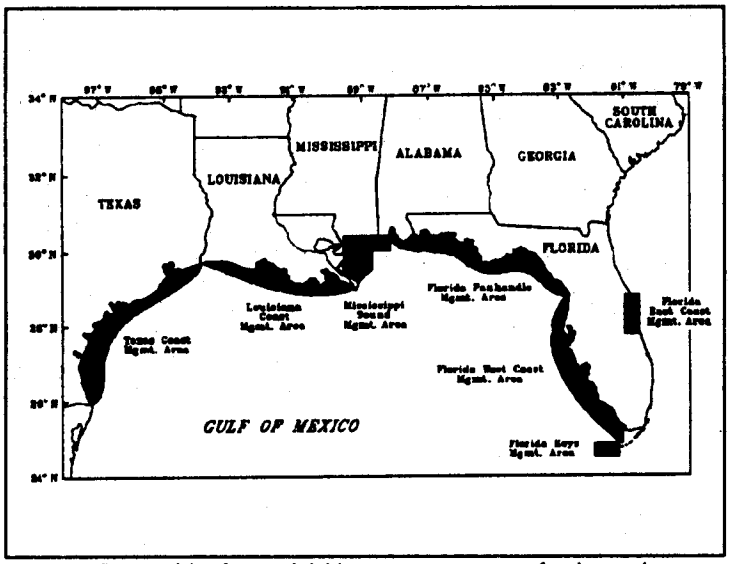

Figure 6. *Proposed bottlenose dolphin management areas for the southeast.*

The recommended quotas represent 2% of the estimated low abundance period for a given management area or subarea. The estimates of abundance are generally believed to be conservative. The degree of underestimation likely varies from area to area. Where possible, embayments generally have been used to define stock boundaries. The proposed management areas are as follows: 1) Texas Coast; 2) Louisiana Coast; 3) Mississippi Sound; 4) Florida Panhandle; 5) Florida West Coast; 6) Florida Keys; 7) Florida East Coast (Figure 6).

The recommended quotas, actual quotas, and numbers removed by management area are given in Staff (1989).

Discussion

Question: Is there any available information on the effects of chase on the availability of dolphins in the various capture locations?
Response: Capture records are available for the last 5-6 years. The records include number chased, captured, how long held, best approximation of age and sex, and location of capture. However, these data have not been analyzed for the possible effects of chase on the dolphin population.
Question: What is the estimated level of abundance of bottlenose dolphins throughout the Gulf of Mexico? How does the Gulf-wide estimate of abundance compare with the annual removal of dolphins by live capture?
Response: Estimates of seasonal point abundance based on the regional aerial surveys of the Gulf of Mexico range from about 35,000-45,000 animals. The majority of these animals are believed to live in waters greater than 18.3m deep. The total number of animals removed for public display and scientific research since 1972 is about 500 with an average of 30-35 taken per year.
Comment: In the Mississippi Sound Management Area there is a large difference in abundance estimates and recommended quota levels when one looks at the Mississippi Sound subregion versus the overall management area.
Response: That is due to interpretation of what was the original sampling study area used by Leatherwood and colleagues in the mid-70's and upon which the original quota of 35 animals was based. Obviously the area involved is quite large and the capture of animals historically has been mainly from areas within the Mississippi Sound proper. That is why we recommended a separate subarea allowable take level for Mississippi Sound proper.

IV.9. *Review of Monitoring Activities*

The need for consistent monitoring data was identified at all reviews: 1982 SAW; 1983 MMC; 1984 SAW; 1985 Large Whale Meeting. The forms of monitoring discussed were "site-specific", "regional", and "stranding." Site-specific monitoring was defined as an ongoing method to extend the available database in specific study areas to yield a site specific perspective. However, differences observed could be confounded by possible shifts in distribution, and extrapolation to the regional system might not be appropriate. Regional monitoring involves consistent sampling of broad areas at about 5 year intervals to yield a system wide perspective. The regional approach may be insensitive to site-specific changes, may require several sampling periods to detect trends, and requires considerable amounts of funds. Strandings can be used to monitor mortality patterns and provide biological samples for analysis. However, maintenance of consistency in effort and reporting in stranding networks is difficult to achieve.

IV.9.1. *Site-specific Monitoring*

The SEFC has established a site-specific monitoring program as part of the long-term studies of bottlenose dolphin populations in southeast US waters. The primary objectives of the site-specific monitoring are to detect large scale interannual changes in relative abundance and/or production. Monitoring has been established in two areas, the Sarasota/Tampa Bays area and the Indian/Banana

Rivers area (Fig. 7), and current plans call for having a total of six areas in the southeast monitored.

IV.9.1.1. *Site-specific Monitoring, Sarasota/Tampa Bays*

In 1987, the SEFC initiated a three-year, monitoring study of the Sarasota/Tampa Bay bottlenose dolphin populations. This work is being performed by Dolphin Biology Research Associates, Inc. under the direction of R.S. Wells. The SEFC provides approximately 50% of the research budget for this monitoring study. The first phase of this contract study required a report summarizing all previous work that could be applied to examine the parameters outlined in the contract: population size, natality, mortality, emigration and immigration. Field studies begun in 1970 and continuing to date have identified at least three adjacent resident communities of bottlenose dolphins along the central west coast of Florida. Photo identification, mark-recapture techniques, behavioral observations, radio-tracking, and brief captures for biological sampling have been used to examine the structure and dynamics of these communities. Community designations are based on consideration of individual home ranges, social association patterns, and genetics. Though the communities are relatively discrete in terms of ranges and associations, electrophoretic analyses of blood samples indicate that genetic exchange occurs between communities. Males travelling between communities appear to be one of the probable vectors for genetic exchange. Most of these field efforts have been concentrated on the Sarasota dolphin community. Most of the members of the Sarasota community are identifiable from natural marks or tagging efforts over the last 19 years. This community consists of about 100 individuals. An analysis was recently completed of 116 dolphins identified during 1980-1987 was recently completed (Wells and Scott 1988). Of the 116, eighty three are of known sex and 56 are of known age. The long time span of the study and the high proportion of identifiable community members has allowed estimation of vital rates for this community and testing of the accuracy and precision of mark-recapture methods. An annual recruitment rate of 0.048 was offset by a minimum mortality rate of 0.01; the mean fecundity rate was 0.142. Knowledge of maternal relationships allowed comparisons of the percentage of calves observed in the field vs. the percentage of young of the year. Because of the prolonged period of association between mothers and calves, there were nearly six times as many mother-calf pairs as mothers with young of the year.

The same survey techniques currently used in the Sarasota area are being applied to the Tampa Bay area by the contractor.

Discussion

Question: Why are the same techniques being applied in the Tampa Bay area?
Response: The area is contiguous to a non-exploited area, therefore this facilitates comparisons with data from ongoing genetic and immigration/emigration studies.

IV.9.1.2. *Site-specific Monitoring, Indian/Banana Rivers*

In 1987, the SEFC initiated a three-year, monitoring study of the Indian/Banana Rivers bottlenose dolphin population. The monitoring is designed to be able to detect a major change in the population size (other than seasonal). Aerial surveys are being conducted seasonally under contract by Mote Marine Laboratory under the direction of G.W. Patton. The survey methods are duplicating the methods used by Leatherwood and Show (1980a) in order to make the new database directly comparable with the pre-existing database.

IV.9.2. *Strandings*

The Southeastern United States Marine Mammal Stranding Network was formally organized in 1977. Between 1981-1985 the SEFC supported stranding network activities. Since 1985, the stranding network has operated in the absence of SEFC funds. In the decade from 1978 to 1987, network volunteers reported 2381 cetaceans, including 74 sightings of live whales, and 3 stranded hooded seals. Cetaceans included 5 species of mysticetes and 23 species of odontocetes. Florida and Texas had the most reports with about 1,081 and 567, respectively. The bottlenose dolphin, and the pygmy sperm whale, *Kogia breviceps*, were the most common singly stranded animals with 1,472 and 224 reports, respectively. Twenty-one mass strandings of 9 species of odontocetes were reported. Seventeen of the mass strandings were in Florida, 2 in Louisiana, and 1 each in Texas and North Carolina.

Strandings can provide information on incidental mortality, although it is not always possible to identify incidental mortality as such. As an example, a young calf observed to have died in a net had hardly any marks on it. Small carcasses are also easily consumed by sharks, and thus may be under represented in strandings. With decomposed animals, incidental mortality probably cannot be identified, unless the carcass is wrapped in a net or other gear.

Although the number of network volunteers has increased over the decade and record keeping has changed from manual to electronic, more attention must be given to the quality and quantity of data gathered, including species verification.

Uniform improvement will require resources that go beyond the limits of volunteerism. Stranding networks are an almost untapped resource for gathering basic data on marine mammals.

Discussion

Question: Could a consistent stranding network exist in the southeast region if funding were available?
Response: Yes, the initial cost would be about $250K, since there are capital costs such as trucks, other field gear and computers. The cost would be less in subsequent years.

IV.10. *Review of Dieoff and Ramifications*

The SEFC was involved in several research activities concerning the massive dieoff of bottlenose dolphins along the US Atlantic coast. These activities included: 1) sampling survey to assess impact of the dieoff on the offshore stock(s) of bottlenose dolphins; 2) beachfront sampling surveys to determine the range and temporal pattern of strandings; 3) analysis of specimen materials for stock structure determination and age class estimation; 4) field and analytical support for clinical aspects of the investigation; and 5) estimation of potential impact on the affected stock.

The potential impact of the dieoff on the offshore stock was assessed with aerial survey sampling. Data collection was completed using contracted aircraft with SEFC staff onboard as observers. All data analysis was conducted by SEFC scientists. Offshore surveys were flown in the mid-Atlantic region from New Jersey to North Carolina during August, 1987, before the dieoff was complete. The sampling area was stratified into offshore and nearshore zones. Sampling methods were consistent with a prior survey of the area (CETAP, 1982). The data from the nearshore stratum was insufficient to draw conclusions concerning the impact on the nearshore stock. The results from the offshore stratum showed an 18% decline in the mean index value. Estimated sampling errors suggested that the probability of some decline in stock abundance was approximately 60%. It was concluded that a decline in the offshore stock, if in fact one occurred, was most likely small (i.e. $<10\%$).

The range and temporal patterns of strandings was evaluated using aerial surveys flown along the coastline from Sandy Hook, NJ, to Savannah, GA. A total of five surveys were completed from August, 1987, through March, 1988, in a cooperative effort with SEFC and Smithsonian Institution investigators. The sightings of live animals and beached carcasses were found to support the hypothesis of a coastal migratory stock of bottlenose dolphins. The pattern of observations suggests the stock moves south during the autumn and north in early spring.

Offshore and nearshore stocks of bottlenose dolphins are believed to occur in US Atlantic waters. Methods of discriminating these stocks are based on materials obtained mostly from animals stranded along the Florida Atlantic coast. The stocks have been characterized by differences in blood chemistry and skull morphometry. Dr. D. Duffield voluntarily conducted an electrophoretic analysis of hemoglobin obtained from 36 animals believed affected by the dieoff: all exhibited the nearshore hemoglobin profile except for one which was an apparent hybrid. A contract analysis of skeletal characteristics and body morphometry by Dr. S. Hersh (Hersh 1988b) concluded that the observed mortality affected primarily, if not exclusively, the nearshore form.

The age class structure of the dieoff was determined under contract to Dr. S. Hersh (Hersh 1988a). Teeth samples were used for age determination, and the age class structure of the dieoff was compared to available pre-dieoff information. There was no significant difference between the age class distributions from the northern and southern ranges of the dieoff, and males and females of each age class were affected equally. All age classes (newborns to 25+ years old) were affected during the dieoff. Proportionately more subadult dolphin (ages 5-9) stranded during the dieoff than in previous studies. High calf mortality was noted and is consistent with other studies.

SEFC scientists completed an assessment of the likely impact of the dieoff and concluded that, as a consequence of the dieoff, the 1987-88 mortality of bottlenose dolphins along the U.S. Atlantic coast was an order of magnitude greater than the prior three-year average observed mortality. Although both coastal and offshore stocks of dolphins are believed to inhabit the waters off the east coast, population surveys and biological samples from stranded and live-captured animals suggests that the observed mortality was principally from a mid-Atlantic coastal, migratory stock of dolphins. Available data suggest a decline of 53% in the stock abundance may have occurred. This assessment is uncertain, however, due mainly to uncertainty in estimates of the natural mortality rate. If this degree of reduction has occurred and this stock proves to be reproductively isolated, then the stock is likely below its optimum sustainable population (OSP) level, and thus a depleted stock. Population trajectories from a 53% reduction level were simulated using a range of vital rate and other demographic parameter values. Under the parameter assumptions used for calculations, no combinations resulted in trajectories toward extinction. The resulting distributions of recovery time to the lower limit of OSP were strongly skewed. In the absence of human-induced mortality, the median time to recovery was 32.5 yr (range, 14-90 yr). Under the assumption of a constant human-induced mortality rate equal to estimates of pre-event rates, the time to recovery estimates ranged from 18 to 100+ yr with a median time to recovery of 50.5 yr. In more than 20% of the cases simulated with human-induced mortality, recovery was not achieved within 100 yrs.

As the recovery standard used in these calculations was the lower limit of OSP, the recovery time estimates can be considered conservative. Uncertainty in the degree of

reduction was not explicitly treated in the simulations run. However, the parameters used result in a large range of reductions from K and thus may reasonably reflect expectations for reductions >53%. In contrast, if the true reduction was less than the specified level then the recovery time distributions are non-conservative.

The available information suggests that there is a reasonably large probability that the affected population of dolphins were depleted by the dieoff in terms of the MMPA. If the coastal stock is designated depleted under the MMPA, the 1988 amendments to the MMPA require that NMFS develop and implement a conservation plan for the stock. Consistent and long-term population monitoring of the affected stock will be necessary to reduce the uncertainty associated with the estimates of recovery. Assumptions about the magnitude of depletion, the degree of human-induced mortality, and the degree of involvement of other bottlenose dolphin stocks need testing via direct experimentation and monitoring. As no consistent pre- and post-event indices are yet available, development of such indices through continued and new population sampling surveys and studies of biological samples from stranded animals will first be needed to test the assumptions.

IV.11. *Review of Human-induced Mortality Estimates*

Prior to the 1988 amendments to the MMPA, incidental take of cetaceans by commercial fisheries could be permitted for non-depleted stocks if the take was determined to be small. The 1988 amendments to the MMPA provide a temporary exemption to the MMPA's General Permit and Small Take provisions which would provide for authorizing the incidental take of marine mammals during commercial fishing operations. The purpose of the exemption, which will last until 1993, is to allow fisheries to continue while gathering information necessary to determine which marine mammal populations are being affected adversely by incidental take in commercial fisheries, and how incidental take might be prevented or reduced. In this context, there are 2 main sources of information on incidental take and other forms of human induced mortality: 1) interviews of fishermen and direct observations of fishing activities, and 2) stranding/salvage programs.

The SEFC has recently reviewed the available stranding/salvage information for southeastern US waters. The information included strandings of: all bottlenose dolphins, 1982-87; all cetaceans, 1974-84; 1987-88 all southeastern US strandings of cetaceans other than bottlenose dolphins. Human-induced mortality was classified into the following 6 categories: 1) net/line entanglement; 2) body parts missing (from other than shark bites); 3) gunshot; 4) propeller wounds; 5) broken bones; 6) other, suggestive of human interactions but not of the above types. The classifications are subjective interpretations and may include post-mortem events. Quality of the data is influenced by the level of consistency of stranding network reports. Bottlenose dolphins were the

species most frequently reported and the most frequently classified as human-induced mortality, but human-induced mortality has also been noted for the following species: right whales, humpback whales, minke whales, pygmy sperm whales, spinner dolphin, and harbor porpoise.

Approximately 7% of all bottlenose dolphin strandings were classified into the above categories. About 9% of bottlenose dolphins stranding on the Atlantic coast from central Florida north were classified as human-induced mortality. Assuming that the categorization scheme is accurate and that the stranding rate is a consistent index of the mortality rate, these proportions imply an overall human-induced mortality rate of 7-9% of total mortality (7.5-9.9% of natural mortality). If the natural mortality estimates of 5-14% per year are accurate, then human-induced mortality may be 0.4-1.4% per year.

Data on incidental take in domestic and foreign fleets operating in US southeastern waters is sparse. From 1977-87 the Foreign Fleet Observer Program reported 6 bottlenose dolphin taken, with 5 of these taken in the mackerel fishery. Observations of the Japanese longline fishery from 1978-87 reported 45 individuals of 6 or more cetacean species either taken or observed nearby the vessels. Between 1982 and 1987 a total of only 5 individual cetaceans were recorded as taken by Japanese longline vessels. Individual observer log sheets for the period of 1978-1981 were not available for study, but it is suspected that reported cetaceans from this period also includes animals captured and animals observed but not captured.

Cetaceans have also been taken incidentally during fishery research operations. Three bottlenose dolphins were encircled (and released) during research purse seine operations which translates to a 0.65% encirclement rate. From 1985-1988 2 spotted dolphins and 2 bottlenose dolphins were taken during experimental butterfish trawl operations. The observer program for the butterfish trawl squid fishery has 20% coverage and has reported no incidental take of marine mammals. During TED (turtle exclusion device) trials in 1986 one bottlenose dolphin was taken. The gear was not used during the trials as it would be in the commercial fishery.

V. Research Presentations: Large Whales

V.1. *Review of Prior Research Recommendations*

Large whale research at the SEFC is influenced by several events. An in-house large whale research planning meeting held at the SEFC in 1985 resulted in recommended research priorities that have been generally followed to the degree possible. The Right Whale Consortium, of which the SEFC is a member and which is

coordinated by the NEFC, has also influenced the research directions of the SEFC concerning right whales. The Recovery Plans currently being developed for right whales and humpback whales also may have impacts on SEFC large whale research plans.

The priority considerations set for large whale research at the 1985 planning meeting were: 1) develop a time-series database for trend analyses; 2) estimate current north Atlantic right whale stock size; 3) estimate right whale catch history; 4) describe right whale breeding ground distribution patterns; 5) estimate recruitment and causes and rates of right whale mortality; 6) estimate recruitment and causes and rates of humpback whale mortality; 7) characterize high-use areas for endangered species; 8) define humpback whale distribution relative to ocean dumping; 9) estimate humpback status relative to OSP using sighting surveys; 10) examine Caribbean land-based fishery records for humpback whales to estimate pre-1800 abundance; and 11) develop protocol for stranding response team to recover biological data from stranded endangered whales.

The SEFC has contributed to the efforts to develop a time series database with research towards the develop of an image analysis system for photoidentification of whales. SEFC has cooperated in development of sampling survey design for estimating right whale stock size. Right whale catch history was reviewed and analyzed under contract. The SEFC has participated in aerial surveys of apparent right whale breeding grounds. The SEFC also provides advisory support for development of the humpback whale Recovery Plan. Other activities will be carried out as funding allows.

V.2. *Right Whale Cooperative Research*

The North Atlantic Right Whale Program (NARWP), made up of federal, academic, and private organizations, was formed to coordinate research on the north Atlantic right whale. This program is managed through the NEFC. The NARWP has been receiving about funds for about 4 years to support several projects concerning right whales. Funding for FY89 is $238K. A principal project is the photoidentification of right whales. Photographs from several research groups are sent to the New England Aquarium for processing and archiving. The difficulty with this system is that field workers do not have good access to photo identification results. Another main project is the compilation and maintenance of individual databases from several sources. This work is being done at the University of Rhode Island, with a primary goal of getting all databases into a compatible format. Surveys of the right whale calving grounds have been conducted. This work has been limited to date and needs to be expanded in time and space to obtain better information on winter distribution. As with almost any consortium, there are problems with distribution and use of what each group may consider proprietary data.

Other work on right whales is also being conducted outside of the NARWP. The Minerals Management Service (MMS) has funded a project to place satellite tags on right whales this summer. This work is being done by Dr. B. Mate. These tags are being tested on right whales for later use on bowhead whales. MMS has also released a request for proposals (RFP) for a study to primarily determine the wintering distribution and abundance of right whales along the southeastern coast of the US. This RFP might result in research that addresses an identified need of the NARWP and underscores the need for enhanced coordination with other agencies which may be conducting or planning research on right whales. Coordination is also needed with other projects, such as SCOPEX a multi-institutional research project run by the University of Rhode Island on the ecology of the Great South Channel. This area is an important habitat for right whales and other cetaceans. There is a definite need for comprehensive plan for right whale research.

V.3. *Endangered Whale Recovery Plans*

The humpback whale Recovery Team was formed in 1987. The first draft of the humpback whale Recovery Plan was reviewed, redrafted and sent for a second review in February 1989. The Recovery Team met in March, 1989, to further review and revise the Plan. The Plan was revised with the single goal of assisting the population to increase by: 1) habitat improvement; 2) decreasing human-induced mortality; and 3) enhancing education and cooperation to maintain and improve the population. The final draft with an implementation schedule is due in August 1989.

The right whale Recovery Team was also formed in 1987. Progress on the right whale Recovery Plan has been at about the same pace as with the humpback plan. The draft recovery plan is expected to be available for public review and comment by the end of December, 1989.

V.4. *Image Processing*

The SEFC contracted for the development and implementation of an image analysis and archival system for the automatic matching and storage of photographs of individually identifiable right whale. This work is being done as part of the SEFC's responsibilities to the NARWP, but the system should have applications to other cetaceans. The objectives of this project are to provide a digital archive for individual identification imagery, and have high speed retrieval and matching abilities greater than current methods. As proposed, the system will provide for digitization and digital archiving of images, image enhancement and classification for assistance in matching, and an menu driven shell system to allow for automated processing of imagery if

desired. A feasibility study and system design proposal have been completed. The necessary hardware and software have been purchased and assembled, but the development of an operational system is not yet complete.

V.5. *Catch History of Right Whales*

A review of the catch history and estimation of pre-exploitation abundance of right whales was conducted under contract by R. Reeves and E. Mitchell (Reeves and Mitchell 1987). The work was funded by the SEFC, NEFC, and the National Marine Mammal Laboratory (NMML).

As part of a broad review of the history of exploitation of right whales in the western North Atlantic, this study attempted to document the removals by shore whalers along the US Atlantic coast from Maine to Florida. All available sources, including published and unpublished, were searched for information on the take of right whales. The resulting catch tables provide a crude and incomplete summary of removals by area and year (Figure 7).

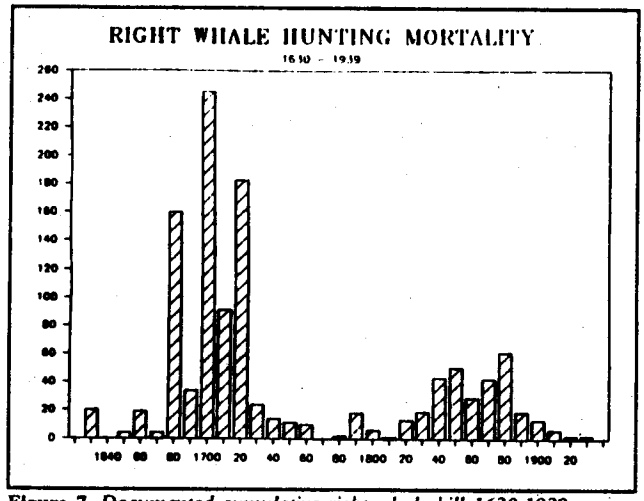

Figure 7. *Documented cumulative right whale kill 1630-1939.*

The catch history for the western North Atlantic stock of right whales should be considered incomplete, and any attempts to estimate early population size for comparison to the present population size must be made with caution. Beginning in the first half of the nineteenth century, there is better documentation for shore-based catches due to the availability of newspapers written for whaling readerships, and for pelagic catches due to the relatively large surviving sample of logbooks and journals. However, by this time the period of greatest catch of Northwest Atlantic right whales was long past.

Based on the incomplete cumulative kill during 1700-1709 (at least 245 right whales, see Figure 7), there certainly were at least some hundreds of right whales in the western North Atlantic in the late seventeenth century. There is little doubt that the kill between Nova Scotia and Florida from 1680 to 1730 was higher than could have been made from a whale population of a few hundred, which is the estimate for the western North Atlantic stock's size in recent years.

Discussion

Comment: The right whale was chosen for the satellite tag testing because when it was tried on bowheads and failed, it was impossible to discover why because the whales could not be followed. The distribution of right whales in the summer is very discrete, so they will be much easier to track after tagging. Also, there is a critical need for information on right whales.
Question: What age/sex classes will be tagged? If we are going to find out more about the winter distributions it may be important to tag females with calves.
Response: Females without calves, and males will be tagged. Ten animals will be tagged initially.
Question: Did MMS consult with NMFS concerning the right whale southeastern U.S. surveys RFP?
Response: Not with SERO.
Response: Not with the Protected Species Office.
Response: MMS did not consult with the NEFC until after the RFP for southeastern U.S. surveys was released. It is obvious that we need to improve coordination with agencies involved with large whales. It may be appropriate to hold a workshop on right whales.
Comment: It is not clear what prompted MMS to release the RFP.
Response: MMS had stopped funding right whale research after it was decided not to conduct lease sales on Georges Bank. It might be that this new RFP is an indication of intentions for leasing activities in the southeastern region.
Comment: Photographic identification data suggests that 50% or more of live right whales show evidence of fishery interaction which indicates that we need to know more about the rate of injury and mortality to right whales from these interactions.

VI. Perceived Research Needs

The SEFC MMP has identified several major research areas of critical importance in the southeast. These include:

1. Monitoring Data: Consistent, long-term data sets are required to determine population trends within reasonable degrees of confidence.

2. Assessments: Improved assessments may be achieved by additional and new analysis of available information.

3. Dolphin Die-Off: Reauthorization language of the MMPA requires further study of the die-off.

4. Human-Induced Mortality: Improved estimates of incidental catch and other human-induced mortality rates are needed.

5. Stock Differentiation: Better information for determining stock separation is needed.

6. Large Whale Research: Needs identified in previous meetings have been only partially addressed.

The degree to which each of these research activities can be addressed within the current expected research funding level are discussed below.

VI.1. *Monitoring Research*

The objective of monitoring research is to detect changes, or trends, in population abundance and/or productivity. For many marine mammal populations we may be more concerned with detecting declining abundance (Holt *et al.* 1987). In these cases, under a null hypothesis of no difference in intersample index values *vs.* the alternative of decline, the risk to the marine mammal stock is better characterized by the probability of incorrect acceptance of the null due to chance. This probability, termed beta error, is different than the traditionally applied alpha error, or probability of falsely rejecting the null due to chance. Thus, one need consider both of these forms of statistical error probability when making determination of change from monitoring data.

The magnitude of detectable change, or critical difference between sampling period index values, is dependent on the degree of acceptable probability of making an incorrect determination from the data at hand and on the precision of the index used for monitoring. The index used for monitoring need not be an accurate measure of the parameter being monitored so long as it is consistent (*i.e.* with an invariant bias term) over the time-horizon for monitoring. A way to control bias and maintain consistency is through the diligent application of the same sampling methodology throughout the monitoring period. Initiating new and improved sampling methods can result in more accurate estimators, but it often confounds interpretation of differences in population parameter estimates over time since methodological differences can not be ruled out as the source of change in the index values. Intercalibration experiments can help to resolve the methodological difference question, although estimation of differential bias terms by these methods adds to the overall uncertainty in the index of population status and thus may increase the critical difference between samples over that which may have resulted using consistent sampling methods. Detection of interannual changes smaller than the critical difference can be achieved through trend analysis as shown by Gerrodette (1987).

Three forms of monitoring research have been discussed at the SEFC. These include regional monitoring, site-specific monitoring, and monitoring trough stranding and salvage networks. Each of these are discussed below.

The regional approach to monitoring marine mammal stocks (for the MMP, the emphasis is the bottlenose dolphin) requires a consistent time series database obtained from regional sampling surveys conducted on a 3-5 year interval. This was the approach recommended by the MMC in 1983 and by the large whale working group in 1985 as a core cooperative research program. The plans were to implement regional surveys throughout the southeast and northeast, with each area surveyed on a rotating basis every 3-5 years. Assuming an index with a coefficient of variation of 20% or less, and acceptable alpha and beta errors of no more than 20%, sampling at a 3-5 year interval would allow detection of average interannual declines of between 10% and 15% by

comparisons made between consecutive samples. Detection of an average annual decline as small as 5% would require at least 3 samples at a 5 year interval and 5 samples at a 3 year interval. The major advantage to this approach is that it provides a system-wide perspective on population trends. Another advantage is that while the sampling is focused on bottlenose dolphins, the entire region is sampled allowing assessment of the relative abundance of other species of concern that would not be expected in more localized, site-specific efforts. Disadvantages include the possible lack of extending a time-series database in certain areas and that the sampling interval may preclude detection of large changes for several years. Regional surveys (conducted with aircraft) would require a constant level of funding (adjusted for inflation) of about $250K per year in contract costs over the time-horizon judged necessary for monitoring. Alternatively, $1,250K every 3 to 5 years could achieve the same level of effort. The current level of MMP funding is inadequate to implement regional monitoring.

Another monitoring approach for bottlenose dolphins stocks is site-specific monitoring. The goal of this research approach is to extend available time series databases in geographically specific study sites to monitor population trends. This approach was implemented by the SEFC in 1987. The objective of this monitoring is to detect interannual doubling or halving of the study area population. Two of an estimated minimum of 6 index area study sites have been established. Site-specific monitoring has some advantages over regional monitoring: faster discovery of large changes, and lower costs. The major disadvantage is that inferences about system changes are based on relatively few study sites. A second disadvantage is that the research is somewhat unattractive to outside-agency investigators since the per contract award is relatively low and the information return is most valuable in a time-frame that extends beyond the average professional life of an individual analyst. The SEFC estimates funding to cover site-specific monitoring contract costs will equal $450K every three years ($75K per 3-year contract term in each of 6 sites). The SEFC opted to phase-in these contracts, over multiple fiscal years to remain within its MMP funding level for contracts, such that $100-150K (1989 constant dollars) in contract funds per year would be sufficient to implement and maintain data collection in 6 study sites. The fiscal year 1989 MMP budget might be sufficient for contracting additional study sites as planned. If adequate contract proposals are received, site specific monitoring of two additional study sites could be in place by the end of 1989. However, the MMP might not be able to let new contracts this late in the fiscal year, given administative time requirements for contracting.

A third monitoring approach is via stranding and salvage networks. The advantage of this approach is that it allows for detection of anomalous die-offs and provides specimen materials for analysis. The disadvantage of this approach is that consistency of effort is difficult to achieve, thus changes in numbers of reported strandings could be due to changes in reporting effort that is not quantified. It was estimated during the review meeting that first year funding for a consistently operating stranding network

would require $250K, with somewhat lower follow-on year funding requirements. The current MMP funding level could provide for some small (less than $15K) increased support of the voluntary network to encourage increased consistency in reporting, but could not approach the $250K level of funding.

Discussion

Question: What levels of change could be detected by the monitoring activities?
Response: The magnitude degree of change that could be detected depends on the precision of the index and the degree of uncertainty one is willing to accept in either falsely rejecting the null hypothesis (alpha error) or falsely accepting the null (beta error), or both. Given equal alpha and beta error probabilities of, say 20% or less (i.e. having an 80% chance of correctly detecting a change, given that it has occurred, while having only a 20% chance of falsely detecting a change due to random errors in sampling), indices with coefficients of variation on the order of 20%, allow detecting declines on the order of 40-45%. Greater precision in the index yields smaller magnitudes of detectable change. Conversely, decreasing the acceptable probability of incorrect determination results in larger magnitude of detectable difference. Small interannual changes could be detected, if the trend was consistent over a time period approximately equivalent to the detectable magnitude change divided by the average annual rate of decline. For instance, an average annual decline of 5% could be detected given the above conditions given an intersample interval of about 10 years, a 10% average annual decline could be detected with an intersample interval of about 5 years, and likewise, an average interannual decline of 15% could be detected in with an intersample interval of about 3 years. Estimates of abundance from the regional surveys have precision generally around 20%, although this varies by the specific area of the sample. Precision in estimates from local surveys have been higher and slightly lower than this figure. An index of abundance that has been used in other monitoring areas such as the eastern tropical Pacific has been the sighting rate (Holt et al. 1987). Use of this index requires the assumption that the number of herds observed per unit of effort is constantly proportional to abundance over the time horizon of monitoring. If this assumption is correct, then the index is advantageous over other less assumption prone indices because its precision will be greater and smaller levels of change can be detected.
Comment: Information from stranding networks can be used to monitor for trouble spots that could then be subjected to more intense study. A case in point is the dolphin die off. This phenomenon was first identified by stranding network investigators at the Smithsonian and as the strandings moved south, the southeastern network cooperators provided critical information to the response team.
Question: What is the objective of the site-specific monitoring?
Response: The design objective is to allow the detection of catastrophic, interannual changes in abundance and or productivity, say a halving or doubling. That is not to say that a smaller intersample difference could not be detected; that depends on the available time-series in existence. Our intention in letting these contracts is to extend the available time-series of data collection in the sites identified. In the Indian/Banana River, this means doing additional aerial surveys applying the methods developed by Leatherwood and Show (1980a). In the Sarasota area, this means using the individual identification approach described by Wells. The information Wells has developed may allow a smaller level of change to be detected since he is essentially censusing his study area population. In other areas the approaches might be different, depending on how potential contractors respond to the RFP's we intend to release. By far, most of the presently available information comes from aircraft surveys. There may be some individual identification data bases available from the Texas coast and there is small vessel and aircraft information available for the Mississippi Sound. In these site-specific monitoring studies we intend for the data collection to be continuing on an annual basis.
Comment: Differences on the order of 10% or less might be observed in data from Sarasota.
Comment: Perhaps the SEFC should alter the objectives of the site-specific monitoring to first be concerned with estimating population vital rates such a natality, mortality, and rates of genetic exchange and de-emphasize the catastrophic change objective. It seems to me that the information coming from the Sarasota study can be applied to other aspects of the MMP.
Response: Information coming from Sarasota is very valuable and continuing the study is important. However, it is not clear that the results can be applied to all groups of dolphins in the region, nor is it clear that the same type of information can easily be obtained in other areas where the population of dolphins may be much larger. The information from the Sarasota area has been developed over a 20-year time history. It is not clear that the SEFC should forgo other forms of sampling in areas where there is already some baseline information. The type of information that can be obtained from these site-specific studies is dependent on the methods applied. It is important to remain consistent within a study site to allow extending the time-series of the data sets available.
Comment: The objective of having 6 study sites for site-specific monitoring may not be easily met, especially with the available funds. There is an obvious need for monitoring in the Mississippi Sound and other areas where there may have been changes in dolphin abundance, yet the RFP released in 1987 produced no respondents proposing to do work in these areas. The work the SEFC is requesting to be done may not be desirable to potential contractors for the amounts available. It is not yet know what response will be to the RFP the SEFC intends to release for contracts in fiscal year 1989. In reality, it may cost considerably more than presently budgeted to do more work of this nature. If that is the case, and there are no additional available funds, the SEFC will have to reevaluate the potential benefits of new site-specific research in respect to their real costs.
Comment: Dr. DeMaster from the Southwest Fisheries Center submitted written comments on the proposed monitoring activities outlined in the briefing packet. His letter has been distributed at the review. The letter also contains comments on the testimony of S. Leatherwood to

the NMFS hearing held on live-capture permits and some other issues that have bearing on the MMP but were not directly discussed at this meeting. His comments on monitoring research follow:

"I think the idea of periodic large scale surveys, that are supplemented with more intense local surveys, is an excellent approach. How often the large scale surveys should be done is a question, but clearly the local surveys should be done at least on an annual basis."

Comment: First priority for monitoring research should be given to implementing the site-specific studies. Then you should consider the regional sampling and request the necessary funding to support such work.

VI.2. *Assessment Research*

The SEFC proposed that improved assessment of bottlenose dolphin stock status can be achieved by full analysis of the available information. As the research to date has focused on baseline data collection and on activities related to the dolphin die-off, the necessary analytical time has not yet been dedicated to this phase of the research plan. Continued assessment research on bottlenose dolphins can be accomplished with the current funds available if other higher priority needs for analytical time are not identified. Plans are to fully analyze all available data on abundance and stock productivity. The assessment of stock status will be based on assumed likely ranges of vital rates and historical exploitation scenarios under various stock hypotheses.

Discussion

Comment: It appears that you have data that would allow one to assess the status of at least some of the bottlenose dolphin stocks. A range of modeling and sensitivity studies could be developed from the information apparently at hand.

Comment: It is important to incorporate estimates of vital rates and stock hypotheses from the Sarasota work and estimates of bycatch into the assessment of status of the stocks.

Comment: Another aspect of analysis that might be beneficial is to investigate the chase and capture data as a method of indexing population abundance.

Question: The MMC has raised a number of issues in its letter of 12 April 1989 (Appendix IV). How does the research proposed address the issues the MMC has raised?

Response: Many of the comments in the letter are have been addressed by this review and in the quota recommendations document prepared by the SEFC and SERO. A point-by-point response to the letter should be drafted and presented to the MMC. One key issue in the quota recommendations and in assessments is the level of incidental take. However, it appears that the level of incidental take would have to be quite high to result in significant detrimental effects on the Gulf of Mexico population of dolphins given the current estimates of abundance presented at this review. There is concern, though, about the large difference seen between the aerial and vessel survey results in the Mississippi Sound. The MMC will recommend that a more detailed review of the available survey data and analyses take place. A workshop may be the appropriate mechanism for this review and the MMC is willing to provide funding for such a meeting. The MMC will forward a letter to NMFS recommending this action and offering support for the task.

VI.3. *Dolphin Dieoff Research*

Several activities have been proposed by the SEFC to address the impact and long-term effects of the bottlenose dolphin dieoff of 1987-88. Large-scale surveys are needed

to assess possible impacts on the offshore dolphin distribution. Localized, small-scale surveys are required to further quantify "before and after" effects of the disease. Sampling should be done for long-term monitoring of the population response to the dieoff. The stock integrity research could be expanded, and the extent of human-induced mortality in existing fisheries and other activities might be better quantified. Also, mortality monitoring could be upgraded by standardization of the effort and reporting of the stranding and salvage network. Full funding for all of these projects would require approximately $900K. Tests of the hypothesis of stock differentiation on the basis of hemoglobin types and skeletal characteristics could be accomplished on an opportunistic nature if offshore bottlenose dolphins are captured and brought to shore by the foreign mackerel fleet.

Discussion

Question: Dr. Geraci's report offered an interesting hypothesis as to the cause of the die off, but there are other hypotheses that may be as likely as the one he championed. There are a number of additional analyses and investigations that could be conducted. Is NMFS planning to further investigate the cause?
Response: Dr. Geraci's report addresses additional research that could be conducted. NMFS has not yet determined all of the needs for further study. However, pressure seems to be mounting to develop a plan for follow-up work. NMFS is pursuing the concept of building a protocol for tissue sampling into our stranding networks and expanding the Alaska tissue bank nationwide.
Comment: Investigation into the cause of the dieoff is not one of the SEFC's responsibilities. The SEFC has concentrated on analysis of the probable impact of the dieoff on the affected population. In this regard, it seems that one of the most productive research activities that the SEFC can undertake is additional aerial surveys to validate the analysis conducted by the SEFC. There is not as great a need to further investigate the discreteness of nearshore and offshore dolphins as Duffield's and Hersh's work did this well.

VI.4. *Human-induced Mortality*

Estimates of human-induced mortality need to be incorporated into the live-capture quota management system. The SEFC proposed that it may be possible to estimate the magnitude of incidental take for marine mammals using available catch and effort data combined with stranding information. Enhancement of the stranding and salvage network to increase the consistency of reporting may be useful. However, it was noted that, unless there is gear attached to the animal or other obvious signs of human-induced mortality, stranding data may underrepresent the true magnitude of by-catch and other forms of human-induced mortality. Observer programs for the dominant fisheries would probably provide the most precise and accurate information on by-catch. It was noted that the two legislated category III fisheries in the bycatch exemption reauthorization language of the MMPA were in the southeast region (shrimp and menhaden). Directed interview sampling may provide additional information on the bycatch rate in the shrimp and menhaden fleets, however directed observation was believed to provide the most reliable information. Current funding levels for the MMP may allow some enhancement of the stranding and salvage network and further analysis

of available by-catch and effort data. Current funding is insufficient to allow new sampling programs to be implemented.

Discussion

Comment: There is a critical need to incorporate estimates of by-catch into quota recommendations for the live capture fishery and assessment of the status of the stocks.
Comment: Dr. Reynolds completed a by-mail survey of incidental take of bottlenose dolphins in the southeast under contract to MMC. You have referenced his work in your summary of the available information. It may be advisable to conduct further direct interviews of fishermen, especially shrimpers and menhaden fishermen, following up on the work of Reynolds.
Comment: The NEFC is planning an approach like this. It may be possible for port agents in the southeast to interview fishermen and get data on marine mammals, although direct observations at-sea would be more reliable.
Question: How reliable are interviews with fishermen for determining bycatch of marine mammals?
Response: Interviews with fishermen result in estimates of turtle by-catch that are about 50% of the observed levels. This result might apply to marine mammals also.
Comment: Studies done by R. Beach and others on the Columbia River have found that direct interviews could be very productive in some cases.
Response: This approach may be good to use with the menhaden industry, but probably not as productive with the shrimping industry.
Comment: The available options for obtaining this information appear to be from direct or indirect observations of the fleets, extrapolation from research vessel trials, and from stranding information. Research vessel results can be very misleading if the fishing gear is not used in a fashion consistent with the industry. Stranding information may not provide very hard results.
Comment: There are limitations to interpreting stranding data. The networks are not consistent and signs of human-induced mortality are not always easy to identify.

VI.5. *Stock Differentiation Research*

The SEFC proposed that some additional aspects of stock differentiation of bottlenose dolphins in the southeast can be addressed using existing data. Density distribution patterns of bottlenose dolphins can be analyzed for natural breakpoints in distribution, which may reflect stock boundaries. The distribution patterns can be overlayed with known home range dimensions for local herds studied to date. Available abundance data can be examined for localized depletion, which may reflect a stock depletion. Current level funding is adequate for these approaches. Two other approaches also could be used, but current funding is not adequate for their implementation. First, there is a considerable amount of skeletal material available that could be analyzed for evidence of differentiation. Also, more biochemical genetics work could be done to estimate along-shore and inshore-offshore differentiation and exchange rates. The stock integrity question as it relates to mid-Atlantic bottlenose dolphins needs further resolution as identified above, especially in light of the proposed ruling for depleted status of the mid-Atlantic coastal migratory stock of bottlenose dolphins.

Discussion

Comment: The question of stock discreetness is an important one relating to the status of the mid-Atlantic bottlenose dolphin population. Sampling animals from the offshore distribution would allow you to test this assumption further. It seems that samples could be obtained from bycatch in the foreign mackerel fleet or relatively inexpensively if a NOAA vessel were used.
Response: The Smithsonian group has been alerted to the need for both blood and skeletal measurements of any bottlenose dolphins that come to them for necropsy off the foreign fleet vessels. The frequency of bottlenose dolphins as bycatch in this fishery is relatively rare, however. The records indicate a bycatch of only 5 animals over the period from 1977-1987.
Comment: The question of inshore and offshore stock differences needs verification by obtaining a valid sample. If a NOAA vessel were used, the cost to the MMP would be low, but if a NOAA vessel were not available then the costs would be high.
Comment: The question of stock differentiation has great bearing on live-capture quota management. It seems to me that the behavioral work, such as being done in Sarasota, provides baseline data that shows great hope for providing a behavioral basis for defining stocks for management purposes. It is essential that this type of research continue and be encouraged.

VI.6. *Large Whale Research*

A number of large whale research activities involving the SEFC have been identified. These activities were essentially unchanged from those identified in prior reviews (Scott 1985). The primary SEFC large whale research that can be achieved with current MMP funding include the following. Complete development of image processing system for right whales. Continue coordination of right whale research with the NARWP. Provide scientific advice during development of the Humpback Whale Recovery Plan. And, increase collaboration with other federal and State research agencies actively conducting large whale research in the region.

Discussion

Question: One of the recommendations made in the 1985 large whale meeting (Scott 1985) was to examine catch records of humpback whales in the Caribbean. Has this recommendation been addressed?
Response: Not as of yet. Perhaps the best place to collect these data are in the tax record archives in Great Britain and other European countries that held colonies in the Caribbean. Records examined in the Caribbean are not centralized and can be in very poor condition.
Question: Another recommendation was to conduct sampling surveys in the Caribbean. Has this recommendation been addressed?
Response: Again, not as of yet. A cooperative shipboard survey involving the other three fishery centers was recommended. It was recommended that by using methods consistent with those used by Winn et al. (1975), there was a reasonable probability of detecting an increase in abundance, especially in the Lesser Antilles where the Bequia fishery may have been suppressing recovery. No vessel time has yet been secured to conduct this research. Although the SEFC is not actively involved in humpback research in the Caribbean, a number of investigators from the northeast are. Annually, the SEFC receives requests for funding to support investigators, some of which the NEFC has supported in the past. The response to these requests is that the SEFC MMP is directed at bottlenose dolphins and that there are no available funds to support field work in the Caribbean. The recommendations made at the 1985 meeting are being reevaluated by the humpback whale recovery team.
Question: Does NMFS have access to military acoustic monitoring station information for use in monitoring whales?
Response: Not on a regular basis.
Question: Why are the priority research tasks identified only for right and humpback whales? What about other endangered large whales in the Gulf of Mexico.
Response: Data requirements for other species have been discussed, but the reason recommended research for right and humpback whales was given highest priority was because of their endangered status and because they are more frequently found in southeastern U.S. and/or Caribbean waters.
Question: What level of resource does the SEFC devote to large whale activities each year?
Response: About 0.5 person-year per year plus travel funds ($2K or less) to attend planning and review meetings.
Question: Are platform of opportunity efforts considered worthwhile in the Gulf of Mexico?
Response: NMFS vessels maintain sighting logs of marine mammals, but effort is not consistent.

Comment: The data from only one NMFS vessel operating in the Gulf of Mexico is of high quality.
Question: Does the vessel maintain an effort log?
Response: It is generally known how much time is spent on-watch by the bridge crew. There is not a dedicated marine mammal observer on board.
Comment: At the NEFC, experience has shown that a dedicated marine mammal observer who maintains a strictly controlled effort log is required before any useful information can be obtained. Otherwise casual observations are not very trustworthy. The NEFC contracts for observers on a number of systematic sampling research cruises each year and the contractors follow the same methods and the cruise tracks are the same year after year, developing a consistent time-series. The level of effort we expend in the northeast costs from $50-70K per year.
Question: Is it reasonable to think that MMS might be in a position to fund large whale surveys in the Gulf of Mexico?
Response: Yes. The SERO has been working with MMS in preparation for the August workshop on protected species information needs in the Gulf. MMS may be able to fund this type of work, if the Exxon Valdez studies do not require all the available funds.
Comment: If NMFS is going to recommend to MMS that they need to fund large whale surveys in the Gulf of Mexico, NMFS should make it clear to MMS that developing a baseline data set is not adequate for determining population status or impacts. Consistent, long-term monitoring studies are required. Consistent archival of the data resulting from these studies is also required.
Comment: It is impractical to attempt to know everything about all marine mammal species in the Gulf of Mexico or other places. I think it is more important to pick and choose species that can be used as indicators and monitor those species using consistent methods over a suitably long time-series. In the Gulf of Mexico, the bottlenose dolphin and West Indian manatee are the two most likely species to be adversely impacted by offshore minerals development.
Comment: The SEFC should not plan any research activities for humpback whales and concentrate what limited resources you have for large whales on right whales, since these are the most endangered.
Response: The priorities for research defined in the 1985 meeting gave a lower ranking to humpback activities than to right whale activities. The SEFC has operated with those priorities.
Comment: The resources the SEFC puts toward humpbacks equate only to staff time, not contract dollars.
Comment: The NEFC would like to see the SEFC assume greater responsibility for right whale research in the southeastern region.
Response: As with humpback whales, the SEFC can contribute staff time to these research activities but nothing else as long as bottlenose dolphin issues remain a high priority and no additional funds are available.
Comment: It is important for the SEFC to continue development of the image processing system. A number of right whale researchers in the northeast are in need of a more efficient way of retrieving, analyzing, and comparing photographic images of right whales.
Question: Characterization of the important right whale wintering areas is an important issue. Can this type of research be piggybacked on research vessels operating in the area on other projects?
Response: The southeast is not the same as the northeast. The areas in the northeast where fishing is concentrated are also areas where resource surveys and whales concentrate. Thus, it is easier to piggyback research operations. In the southeast during the winter, there is not much fishing or research activity where right whales may be concentrated.
Comment: The Navy funded a right whale study offshore of the Kings Bay, GA submarine base and found a large amount of vessel activity in the area. Perhaps the Navy is an appropriate source of funds for this type of research in the southeast.

VII. Review Team Findings and Research Recommendations

The findings and recommendations reported herein arose from the review team's discussion of proposals put forward in section VI and from comments on the draft report received from participants.

Findings

All of those who participated in the program review believed that present funding and staff levels are insufficient to conduct the needed research. The review team recommended that funding for research needs be pursued from several different agencies in addition to within NMFS. The agencies identified as having possible marine mammal research funding responsibilities that would address MMP needs included the Navy, MMS, and EPA. However, the review team also recognized that most of the priority issues identified require research activities that clearly fall under the NMFS

MMPA mandate. The review team found that increased commitment for the MMP from NMFS and SEFC was needed for the MMP to maintain any effectiveness. The review team suggested that an increase in the dedicated MMP staff level should be considered by the SEFC. Increased staff would allow for more dedicated marine mammal research activities and enhance the SEFC's ability to attract outside agency funding for the identified research tasks. Conditional on increased agency commitment for the MMP, the review team suggested that the MMP develop specific research project budgets to address each of the research recommendations made by the review team and use these as a basis for requesting the necessary funding levels to accomplish the recommended tasks.

Reviewers commented that the MMP appears to be viewed as a "secondary" resource issue driven by short-term problems. Although long-term priority topics have been discussed and developed in the MMP over the past few years, the reviewers found little commitment to ensure that appropriate scientific information can be obtained in advance of a problem. Reviewers questioned the priority given research directed at management of the live-capture fishery, considering the relative size of the bottlenose dolphin population in and near the Gulf of Mexico, and the low numbers of animals removed by the fishery. While the quality of the research is high, reviewers commented that the more important issue from a NMFS perspective may be to investigate the broader resource and ecological questions relative to marine mammal habitat and abundance assessments. Lastly, reviewers cited evidence of significant improvement in the quality of the MMP over the past 3-4 years, in spite of budget cutbacks. MMP publications and reports in the period from 1979-1985 averaged 5.3 per year while the number averaged 10.8 per year from 1986-1989. More importantly, since 1987, peer reviewed publications have increased 50% over the previous 8 years.

Research Recommendations

The review team gave highest priority to the further development of monitoring data sets. A combination of annual site-specific studies directed at bottlenose dolphins, supplemented by broader-scale, consistent regional sampling on a 3-5 year sampling interval was considered to be an appropriate approach to developing a monitoring data set. It was **recommended** that the site-specific monitoring studies first be implemented before additional region-wide surveys are conducted. The review team **recommended** that, at a minimum, the ongoing studies in the Indian/Banana River and Sarasota/Tampa Bays be continued and that at least one additional site-specific monitoring study be initiated in the Gulf of Mexico, preferably in the Mississippi Sound. It was further **recommended** that the SEFC first complete a power analysis for trend with the available survey data in order to fully specify the sampling design and associated funding necessary to detect levels of population change that will insure that management requirements under the MMPA can be met by these methods. The review

team also **recommended** that the SEFC evaluate the utility of stranding network data for the purpose of monitoring dolphin stock status. It was recognized by the review team that current MMP funding is inadequate to meet the defined monitoring data requirements.

The review team **recommended** that improved assessments could be achieved by fully analyzing the available information. It was considered important to include in these assessments the estimates of vital rates developed from the Sarasota studies. The review team expressed concern over the large differences in abundance estimates resulting from different sampling platforms and **recommended** that a detailed review of the survey data and associated analyses by a group of specialists take place during the summer of 1989. To accommodate this review, the MMC and NMFS Office of Protected Species and Habitat Programs offered funding for a workshop if one is determined to be necessary. The review team also **recommended** that live-capture quota recommendations be developed which account for estimated by-catch in other fisheries operating in the southeast. The review team recognized that assessment research requiring no new data could be accomplished by the MMP.

The review team **recommended** that the impact of the dolphin dieoff needs to be further investigated. Greater resolution of the uncertainty associated with the degree of impact on the affected population can best be addressed by 1) sampling the offshore distribution of dolphins to test the hypothesis of "small" impact on the offshore distribution by comparison with pre die-off samples; 2) development of consistent population indices for the nearshore distribution to allow "before and after" comparisons to refine estimates of impact and to monitor population recovery; 3) testing the hypothesis of stock discreteness between nearshore and offshore dolphins via collection of a statistically sound number of specimens. The review team recognized that the MMP could not conduct these research activities given the current level of funding, except some stock discreteness research if samples are collected opportunistically through bycatch in commercial fishing operations in the mid-Atlantic offshore region. It was **recommended** that this research become part of the NMFS conservation plan for the mid-Atlantic bottlenose dolphin stock as required under the 1988 amendments to the MMPA if the stock is designated depleted.

The review team recognized that a critical need is to obtain reliable estimates of the number, age, sex, and reproductive condition of bottlenose dolphins and other marine mammals being caught, injured, or killed incidental to commercial fishing operations in the southeast. The review team **recommended** that improved estimates of human-induced mortality of bottlenose dolphins and other marine mammal species in the southeast could be achieved through improvement of the consistency of stranding and salvage data collection and additional analysis of the available information. The review team also noted that biological samples necessary for a range of studies on the relative health and status of southeastern U.S. bottlenose dolphin stocks could be

obtained if the Stranding Network were better supported. The review team recognized that current funding of the MMP is inadequate to allow substantial improvement in the network operation. The review team recognized that some additional information can be expected from observer coverage of the longline fleet, however, other fisheries in the southeast will not be sampled in this fashion under the MMPA exemption process. The review team **recommended** that directed interviews of the menhaden and shrimp fleets are an appropriate first step to improving estimates of by-catch rates and total mortality of marine mammals by these fisheries in the region. The review team further recognized that current funding of the MMP is inadequate to conduct such interview sampling.

The review team recognized that better information on the distribution, movements, and genetic relatedness of inshore-offshore stocks and coastal concentrations of bottlenose dolphins is needed to more reliably assess and develop management strategies for minimizing the possible adverse effects of live-capture fisheries, incidental mortality during commercial fishing operations, entanglement in lost and discarded fishing gear and other marine debris, and habitat alteration due to coastal and offshore development. The review team **recommended** that the MMP should focus further research on stock differentiation in bottlenose dolphins on implications for management of the live-capture fishery. The hypothesis of local stock differentiation was identified as a critical, major issue underlying the management of live-capture fishery. It was agreed that it is essential to continue the behavioral work (e.g, to determine residency patterns, rates of genetic exchange, etc.) at Sarasota and initiate research at other sites since this baseline data holds great promise for providing a behavioral basis for defining stocks for management purposes. The review team recognized that current funding to the MMP may be inadequate to initiate new research in this area and **recommended** that research funding from the Navy be pursued since it is the major consumer of live-capture dolphins and from MMS because of its responsibilities for oversight of development activities.

The review team recognized that the most critical large whale information needs in the southeast are to determine when, where, and how many right whales are present and calve in areas off the coasts of North Carolina, South Carolina, Georgia, and eastern Florida, and to identify populations of endangered cetaceans that possibly could be affected by oil and gas exploration and development in the Gulf of Mexico. The review team **recommended** that highest priority be given to right whales in the MMP large whale research activities. The review team recognized that the current funding for the MMP is inadequate to initiate any new research on right whales or other endangered cetaceans. The review team **recommended** that the image processing system under development for right whale photographic data be completed. It was also **recommended** that further research on the distribution and abundance of right whales in the southeastern US winter distribution be conducted. The review team **recommended** that this research would best be accomplished through cooperation and

collaboration with the MMS since that agency has advertised its intent to fund surveys of this nature in the southeastern US Atlantic. It was **recommended** that no new research on humpback whales be initiated unless specific funding for this research becomes available. It was also **recommended** that the MMP collaborate and cooperate with MMS in development of the baseline information needs for ESA Section 7 consultations relating to deep water minerals development in the US Gulf of Mexico.

References

Alldredge, J.R., and C.E. Gates. 1985. Line transect estimators for left-truncated distributions. Biometrics. 41:273-280.

Asper, E.D., and D.K. Odell. 1981. *Tursiops truncatus* studies bottlenose dolphin local herd monitoring: capture, marking, collection of biological data, and follow-up observations of marked animals. Final Report, Contract No. NA79-GA-C-00027.

Buckland, S.T. 1985. Perpendicular distance models for line transect estimators. Biometrics. 41:177-195.

Burn, D. 1988. NOAA/Smithsonian Cooperative Mid-Atlantic Bottlenose Dolphin Aerial Survey Program: Final Report. NMFS/SEFC, Miami Laboratory, Coastal Resources Division, Contribution ML-CRD-87/88-23.

CETAP, 1983. A characterization of marine mammals and turtles in the mid- and North Atlantic areas of the U.S. outer continental shelf. Final report of the Cetacean and Turtle assessment program. Bureau of Land Management Contract No. AA51-CT8-48. US. Department of Interior, Washington, DC. 450pp.

Duffield, D. 1987. Investigation of genetic variability in stocks of the bottlenose dolphin (*Tursiops truncatus*) and the loggerhead sea turtle (*Caretta caretta*). Contract Report NA83-GA-C-00036.

Duffield, D. and R.S. Wells. 1987. Population structure of bottlenose dolphins: genetic studies of bottlenose dolphins along the central west coast of Florida. Contract Report 40-WCNF-00366.

Eberhardt, L.L. 1985. Assessing the dynamics of wild populations. J. Wildl. Manage. 49:977-1012.

Gerrodette, T. 1987. A power analysis for detecting trends. Ecology. 68(5):1364-1372.

Harrison, R.J., R.L. Brownell, Jr. and R.C. Boice. 1972. Reproductions and gonadal appearance in some odontocetes. Pages 362-429 *in* R.J. Harrison, ed. Functional anatomy of marine mammals, Vol. 1. Academic Press, New York, NY. 451pp.

Hansen, L.J. and G.P. Scott. 1989. Bottlenose dolphin densities in five selected southeastern United States areas during 1981-83. NMFS/SEFC, Miami Laboratory, Coastal Resources Division, Contribution ML-CRD-88/89-08.

Hersh, S.L. 1987. Characterization and differentiation of bottlenose dolphin populations (Genus *Tursiops*) in the southeastern U.S. based on mortality patterns and morphometrics. Phd Dissertation, University of Miami, Florida. 213pp.

Hersh, S.L. 1988a. Age class distribution of bottlenose dolphins stranded during the east coast die-off of 1987/1988. Contract Report 45-WCNF-800633.

Hersh, S.L. 1988b. Analysis of skull and body morphometrics of bottlenose dolphins stranded during the 1987/1988 east coast die-off. Contract Report 45-WCNF-800633.

Hohn, A.A. and P.S. Hammond. 1985. Early postnatal growth of the spotted dolphin, *Stenella attenuata*, in the offshore eastern tropical Pacific. Fish. Bull. (U.S.). 83:553-566.

Holt, R.S., T. Gerrodette and J.B. Cologne. 1987. Research vessel survey design for monitoring dolphin abundance in the eastern tropical Pacific. Fish. Bull, U.S. 85(3):435-446.

Leatherwood, S., and R.R. Reeves. 1983. Abundance of bottlenose dolphins in Corpus Christi Bay and coastal southern Texas. Contri. Marine Sci. 26:179-199.

Leatherwood, S., R.R. Reeves and I.T. Show. 1982. Effects of varying altitude on aerial surveys of bottlenose dolphins. Rep. Int. Whal. Commn. 32, 1982:569-575.

Leatherwood, S., and I.T. Show. 1980a. Development of systematic procedures for estimating sizes of "population(s)" of bottlenose dolphins and estimates of sizes of "population(s)" of bottlenose dolphins in three geographical areas; with incidental observations on densities of West Indian manatees and marine turtles. Final Report, Contract No. NA79-GA-C-0038.

Leatherwood, S., and I.T. Show. 1980b. A comparison of results from vessel and aircraft censuses of bottlenose dolphins off the west coast of Florida (September 1979) and in Indian River, Florida (November 1979). A supplement to the Final Report on Contract No. NA79-GA-C-0038.

Leatherwood, S., I.T. Show, R.R. Reeves and M.B. Wright. 1982. Proposed modification of transect models to estimate population size from aircraft with obstructed downward visibility. Rep. Int. Whal. Commn. 32, 1982:577-580.

Leatherwood, S., S. Swartz and M.L. Jones. 1979. Preliminary report on an inventory of bottlenose dolphins in a region of the Florida west coast, September 1979, with a comparison of results of concurrent aerial and small boat surveys. Interim Report, Contract No, NA-79-GA-C-00038.

Lohoefener, R., W. Hoggard, R. Ford, and J. Benigno. in prep. a. Studies of Mississippi Sound bottlenose dolphins. Determining the effects of the removal of 30 adult bottlenose dolphins from the Mississippi Sound. Part 1 (of 2) of the Final Report to the U.S. Marine Mammal Commission, 1625 Eye Street, NW Washington, D.C. 20006.

Lohoefener, R., W. Hoggard, R. Ford and J. Benigno. in prep. b. Studies of Mississippi Sound bottlenose dolphins. Apparent abundance: line transect studies using a small boat study platform. Part 2 (of 2) of the Final Report to the U.S. Marine Mammal Commission, 1625 Eye Street, NW, Washington, D.C. 20006

Odell, D.K., and E.D. Asper. 1982. Live capture, marking, and resighting of bottlenose dolphins, *Tursiops truncatus*. Final Report, Contract No. NA80-GA-C-00063.

Mullin, K.D. 1988. Comparative seasonal abundance and ecology of bottlenose dolphins (*Tursiops truncatus*) in three habitats of the north-central Gulf of Mexico. Ph.D. dissertation, Mississippi State Univ., Mississippi State, MS. 135 pp.

Odell, D.K., D.B. Siniff and G.H. Waring. 1975. *Tursiops truncatus* assessment workshop. NTIS, No. PB-291-161. 141 pp.

Powers, J.E. (editor). 1982. Report of the first Southeast Fisheries Center stock assessment workshop.

Powers, J.E. (editor). 1984. Report of the second Southeast Fisheries Center stock assessment workshop.

Prescott, J.H., S.D. Kraus, and J.R. Gilbert. 1980. East coast/Gulf coast cetacean and pinniped research workshop report. Final Report to the US Marine Mammal Commission, Report No. MMC 79/02, NTIS Pub. No. PB80-160104. 142pp.

Reeves, R.R. and E. Mitchell. 1987. Shore whaling for right whales in the northeastern United States. Contract Report NA85-WC-C-06194.

Reilly, S.B. and J. Barlow. 1985. Rates of increase in dolphin population size. Fish. Bull. (U.S.) 84:527-533.

Sergeant, D.E., D.K. Caldwell and M.C. Caldwell. 1973. Age, growth, and maturity of bottlenosed dolphin (*Tursiops truncatus*) from northeast Florida. J. Fish. Res. Bd. Canada. 30:1009-1011.

Scott, G.P. (ed.). 1985. Report of the working group on NEFC/SEFC marine mammal research. Results of the meeting held 8-9 January, 1985. NOAA Technical Memorandum NMFS-SEFC-168. 27pp.

Scott, G.P.and D.M. Burn. 1987. The potential impact of the 1987 mass mortality on the Mid-Atlantic offshore stock of bottlenose dolphins. NMFS/SEFC, Miami Laboratory, Coastal Resources Division Contribution ML-CRD-87/88-10.

Scott, G.P., D.M. Burn, L.J. Hansen. 1988. The dolphin dieoff: long term effects and recovery of the population. Proceedings: Oceans '88. IEEE Cat. No. 88-CH2585-8. Vol. 3:819-823.

Scott, G.P., D.M. Burn, L.J. Hansen and R.E. Owen. 1989. Estimates of bottlenose dolphin abundance in the Gulf of Mexico from regional aerial surveys. CRD-88/89-07.

Solangi, M.A., and G.E. Dukes. 1983. Atlantic bottlenose dolphin, *Tursiops truncatus* herd studies in the Mississippi Sound, U.S.A.,: capture, freeze marking and biological sampling. Final Report, Contract No. NA82-GA-C-00023.

Thompson, N.B. 1981a. Estimates of abundance of *Tursiops truncatus* in Tampa Bay, Florida. NOAA/NMFS/SEFC/Miami Laboratory, Fishery Data Analysis Division Technical Report.

Thompson, N.B. 1981b. Estimates of abundance of *Tursiops truncatus* in Charlotte Harbor, Florida. NOAA/NMFS/SEFC/Miami Laboratory, Fishery Data Analysis Division Technical Report.

Thompson, N.B. 1981c. Estimates of abundance of *Tursiops truncatus* in the Indian-Banana River Complex, Florida in 1980. Page 118 *In:* Abstracts, Fourth Biennial Conference on the Biology of Marine Mammals, San Francisco, California, Dec 14-18, 1981.

Thompson, N.B. 1982a. Estimates of abundance of *Tursiops truncatus*, the bottlenose dolphin in: St. Joseph-Apalachicola Bays, Florida; Mississippi Sound, Mississippi; and the Aransas-Copano-San Antonio Bay complex, Texas. NOAA/NMFS/SEFC/Miami Laboratory, Fishery Data Analysis Division Technical Report.

Thompson, N.B. 1982b. Estimate of abundance of *Tursiops truncatus* in Corpus Christi Bay, Texas, September, 1979. NOAA/NMFS/SEFC/Miami Laboratory, Fishery Data Analysis Division Technical Report.

Wells, R.S. 1987. Population structure of bottlenose dolphins: behavioral studies along the central west coast of Florida. Contract Report 40-WCNF-00366.

Wells, R.S. and M.D. Scott. 1988. Estimating bottlenose dolphin population parameters from individual identification and capture-release techniques. Contract Report 50-WCNF-7-06083.

Winn, H.E., R.K. Edel and A.G. Taruski. 1975. Population estimate of the humpback whale, *Megaptera novaeangliae,* in the West Indies by visual and acoustic techniques. J. Fish. Res. Board Can. 32(4):499-506.

Appendix I: Meeting Agenda

Convene 0900, 2 May, 1989

I. Introduction, Welcome, Terms of Reference: B. Brown, W. Nelson

II. Historical Perspective of Program: J. Powers

III. Issues
- III.1. National Management Issues: N. Foster
- III.2. Marine Mammal Commission Critical Issues: R. Hofman
- III.3. Regional Management Issues: C. Oravetz

IV. Research Presentations
- IV.1. Stock Differentiation: L. Hansen
  - IV.1.1. Herd Biodynamics Studies
    - IV.1.1.1. Indian/Banana River: D. Odell
    - IV.1.1.2. Mississippi Sound: L. Hansen
  - IV.1.2. Behavioral Indices: R. Wells
- IV.2. Review of Localized Surveys: L. Hansen
- IV.3. Review of Mississippi Sound Abundance Estimates: R. Lohoefener
- IV.4. Review of Chandeleur Sound Abundance Estimates: K. Mullin
- IV.5. Review of Regional Surveys Abundance Estimates: G. Scott
- IV.6. Review of Chandeleur Sound Model: K. Mullin
- IV.7. Surveys of Turtles and Oil Rigs: R. Lohoefener
- IV.8. Review of Quota Recommendations: G. Scott
- IV.9. Review of Monitoring Activities: G. Scott
  - IV.9.1. Site-specific Monitoring: L. Hansen
    - IV.9.1.1. Site-specific Monitoring, Sarasota/Tampa Bays: R. Wells
    - IV.9.1.2. Site-specific Monitoring, Indian/Banana Rivers: G. Patton
  - IV.9.2. Strandings: D. Odell
- IV.10. Review of Dieoff and Ramifications: G. Scott
- IV.11. Review of Human-induced Mortality Estimates: G. Scott

V. Research Presentations: Large Whales
- V.1. Review of Prior Research Recommendations: G. Scott
- V.2. Right Whale Cooperative Research: T. Smith
- V.3. Humpback Whale Recovery Plan: H. Braham
- V.4. Image Processing: G. Scott
- V.5. Catch History of Right Whales: L. Hansen

VI. SEFC Perceived Marine Mammal Research Needs: W. Nelson
- VI.1. Monitoring Research: G. Scott
- VI.2. Assessment Research: G. Scott
- VI.3. Dolphin Dieoff Research: G. Scott
- VI.4. Human-induced Mortality Research: G. Scott
- VI.5. Stock Differentiation Research: G. Scott
- VI.6. Large Whale Research: G. Scott

VII. Review Team Research Recommendations: Review Team

Adjourn, 1530, 3 May, 1989

Appendix II

a) Participants In The Marine Mammal Program Review

Dr. Joseph W. Angelovic
Acting Director
National Marine Fisheries Service
Southeast Regional Office
9450 Koger Boulevard
St. Petersburg, FL 33702

Dr. Howard W. Braham
Director
National Marine Fisheries Service
Northwest and Alaska Fisheries Centers
National Marine Mammal Laboratory
7600 Sandpoint Way, Bldg. 4
Seattle, WA 98115

Dr. Bradford E. Brown
Acting Director
National Marine Fisheries Service
Southeast Fisheries Center
75 Virginia Beach Drive
Miami, FL 33149

Ms. Wanda Cain
Fishery Biologist
National Marine Fisheries Center
Office of Protected Resources and
Habitat Programs
1335 East-West Highway
Silver Spring, MD 20910

Dr. Nancy Foster
Director
National Marine Fisheries Service
Office of Protected Resources and
Habitat Programs
1335 East-West Highway
Silver Spring, MD 20910

Dr. William W. Fox, Jr.
Professor and Director
Cooperative Institute for Marine
and Atmospheric Studies and
Chairman, U.S. Marine Mammal Commission
University of Miami
4600 Rickenbacker Causeway
Miami, FL 33149

Mr. Larry J. Hansen
Fishery Biologist
National Marine Fisheries Service
Southeast Fisheries Center
Miami Laboratory
75 Virginia Beach Drive
Miami, FL 33149

Dr. Robert J. Hofman
Scientific Program Director
U.S. Marine Mammal Commission
1625 Eye Street, N.W.
Washington, DC 20006

Dr. Charles Karnella
Chief, Protected Species Mgmt. Division
National Marine Fisheries Service
Office of Protected Resources and
Habitat Programs
1335 East-West Highway
Silver Spring, MD 20910

Dr. Ren Lohoefener
Ecologist
National Marine Fisheries Service
Southeast Fisheries Center
Pascagoula Laboratory
P.O. Drawer 1207
Pascagoula, MS 39568

Dr. Keith D. Mullin
Fishery Biologist
National Marine Fisheries Service
Southeast Fisheries Center
Pascagoula Laboratory
P.O. Drawer 1207
Pascagoula, MS 39568

Dr. Walter R. Nelson
Director and Protected Species
Program Manager
National Marine Fisheries Service
Southeast Fisheries Center
Miami Laboratory
75 Virginia Beach Drive
Miami, FL 33149

Dr. Daniel K. Odell
Staff Research Biologist
Sea World of Florida
7007 Sea World Drive
Orlando, FL 32821

Mr. Charles A. Oravetz
Chief, Protected Species Management Branch
National Marine Fisheries Service
Southeast Regional Office
9450 Koger Boulevard
St. Petersburg, FL 33702

Mr. Geoffrey W. Patton
Marine Mammal Program Manager
Mote Marine Laboratory
1600 City Island Park
Sarasota, FL 34236

Dr. Joseph E. Powers
Chief, Coastal Fisheries Resources Division
National Marine Fisheries Service
Southeast Fisheries Center
Miami Laboratory
75 Virginia Beach Drive
Miami, FL 33149

Dr. Gerald P. Scott
Fishery Biologist
National Marine Fisheries Service
Southeast Fisheries Center
Miami Laboratory
75 Virginia Beach Drive
Miami, FL 33149

Dr. Tim D. Smith
Chief, Population Dynamics Branch
National Marine Fisheries Service
Northeast Fisheries Center
Woods Hole, MA 02543

Dr. Nancy B. Thompson
Fishery Biologist
National Marine Fisheries Service
Southeast Fisheries Center
Miami Laboratory
75 Virginia Beach Drive
Miami, FL 33149

Dr. Michael F. Tillman
Senior Scientist for Fisheries
National Marine Fisheries Service
1335 East-West Highway
Silver Spring, MD 20910

Dr. Randall S. Wells
Guest Investigator
Woods Hole Oceanographic Institute
Woods Hole, MA 02543

b) Invited Persons Who Could Not Attend The Review

Dr. William Aaron[1]
Director
National Marine Fisheries Service
Alaska Fisheries Center
7600 Sand Point Way N.E., Bldg. 4
Seattle, WA 98115

Dr. Izadore A. Barrett[1]
Director
National Marine Fisheries Service
Southwest Fisheries Center
P.O. Box 271
La Jolla, CA 92038

Dr. Richard J. Berry[1]
Director
National Marine Fisheries Service
Northwest Fisheries Center
2725 Montlake Boulevard E.
Seattle, WA 98112

Dr. Gerald Bratton
Department of Veterinary Anatomy
Texas A&M University
College Station, TX 77843

Dr. Ford A. Cross
Director
National Marine Fisheries Service
Southeast Fisheries Center
Beaufort Laboratory
Pivers Island
Beaufort, NC 28516

Dr. Douglas P. DeMaster[2]
Chief, Marine Mammals and Fisheries
Interactions Division
National Marine Fisheries Service
Southwest Fisheries Center
P.O. Box 271
La Jolla, CA 92038

Dr. Edward F. Klima
Director
National Marine Fisheries Service
Southeast Fisheries Center
Galveston Laboratory
4700 Avenue U
Galveston, TX 77551

Dr. Robert A. Kifer
Director
National Marine Fisheries Service
Southeast Fisheries Center
Charleston Laboratory
James Island, P.O. Box 12607
Charleston, SC 29412

Dr. Andrew J. Kemmerer[1]
Director
National Marine Fisheries Service
Southeast Fisheries Center
Mississippi Laboratories
P.O. Drawer 1207
Pascagoula, MS 39568

Dr. William H. Lang
Programs Coordinator
Minerals Management Service
Mail Stop 644
Reston, VA 22091

Dr. Kumar Mahadevan[1]
Director
Mote Marine Laboratory
1600 City Island Park
Sarasota, FL 34236

Mr. Allen E. Peterson, Jr.[1]
Director
National Marine Fisheries Service
Northeast Fisheries Center
Woods Hole, MA 02543

Dr. John E. Reynolds, III
Chairman
Department of Biology
Eckerd College
P.O. Box 12560
St Petersburg, FL 33733

Dr. Karen Steidinger
Chief, Bureau of Marine Science and
Technology
Florida Department of Natural Resources
100 8th Ave., S.E.
St. Petersburg, FL 33701

Mr. John R. Twiss, Jr.[1]
Executive Director
U.S. Marine Mammal Commission
1625 Eye Street, N.W.
Washington, D.C. 20006

---

[1] A representative participated in the review.

[2] Review comments were received by mail.

Appendix III

Abstracted technical reports, contract reports,
and other reports on marine mammals resulting from
SEFC research support.

Titles and Abstracts are categorized by the primary research activity to which they pertain. Abstracts were composed for reports without abstracts. Some abstracts have been shortened from the original submission. Research category codes are as follows:

A - Stock Abundance Research
S - Stock Discrimination Research
P - Stock Productivity Research
D - Dolphin Die-off Research
L - Large Whale Research
R - Review, Planning, and Integrative Research Reports
O - Other

Titles and Abstracts are also footnoted. Footnotes are as follows:

[1]Staff reports.
[2]Contract reports.
[3]Reports resulting from partial SEFC support or collaboration, but which were not directly contracted.

[2]Asper, E.D., and D.K. Odell. 1981. *Tursiops truncatus* studies bottlenose dolphin local herd monitoring: capture, marking, collection of biological data, and follow-up observations of marked animals. Final Report, Contract No. NA79-GA-C-00027.

Between August and December, 1979, a study was conducted on the bottlenose dolphin (*Tursiops truncatus*) population inhabiting the Indian and Banana Rivers on the east coast of Florida. Data were collected on morphometrics, blood chemistry, age, bacterial and fungal flora/fauna, biochemical genetics, mark longevity, and the movements of marked animals (17 males, 8 females). Calves comprised 8.1% of dolphins sighted. Some of the marked animals, particularly the males, seemed to move extensively up and down the Indian River and some entered the Banana River. Herd structure appeared to be highly dynamic although several animals were always seen together. Sightings of marked animals made after the study suggest that some dolphins may move south as colder weather approaches.

[3]Asper, E.D., L.H. Cornell, D.A. Duffield and D.K. Odell. in press. Hematology and serum chemistry values in bottlenose dolphins. *In* S. Leatherwood and R.R. Reeves, (eds.), the bottlenose dolphin. San Diego, Academic Press.

Normal values and ranges for a panel of 31 hematology and serum chemistry tests are presented for bottlenose dolphins. Values for these clinical tests were derived from long-term health records of bottlenose dolphins at the Sea Worlds of California and Florida. Age-related differences in normal values and ranges were found for total white blood cell count, the percentage of neutrophils and lymphocytes, glucose levels, and various clinical enzyme activities (alanine aminotransferase, aspartate aminotransferase, alkaline phosphatase, creatinine kinase and lactic dehydrogenase). Sex-related differences in normal values and ranges were noted for iron and for total iron binding capacity. "Normal" values for the hematology and serum chemistry tests for captive animals were compared with values obtained from wild bottlenose dolphins in the Banana-Indian River complex of eastern Florida. The values were similar for most of the tests. Statistically significant differences in mean values between captive and wild dolphins were seen in total white blood cell count, in the percentage of neutrophils and eosinophils, in total protein, albumin and globulin levels, and in serum urea nitrogen, cholesterol and triglyceride levels. The differences in the white blood cell parameters and in the total protein, albumin and globulin levels suggest a greater antigenic challenge for wild dolphins. The differences in levels of serum urea nitrogen, cholesterol, and triglycerides possibly reflect differences in diet and exercise.

[3]Barros, N.B., and D.K. Odell. in press. Food habits of bottlenose dolphins (*Tursiops truncatus*) in the southeastern United States. *In* S. Leatherwood and R.R. Reeves, (eds.), The bottlenose dolphin. San Diego, Academic Press.

Stomach contents of 76 bottlenose dolphins stranded in the southeastern United States from 1973 to 1987 were examined. The most common food remains were from fish, but cephalopods and shrimp were also found. Otoliths from 43 species, distributed in 39 genera and 25 families were found in the dolphin stomachs. Twenty-nine prey taxa have not previously been among the known prey of bottlenose dolphins in the western North Atlantic. Cephalopod beaks recovered from all stomachs represented 387 specimens in 3 families. Important prey species, judging by frequency of occurrence and abundance in the stomachs, are *Bairdiella chrysoura*, *Micropogonias undulatus*, *Cynocion arenarius*, *Mugil* sp. and *Lolliguncula brevis*.

Evidence from this study and others suggest that bottlenose dolphins are weaned at a body length of 170 to 180 cm. Geographic variation in diet was observed, coinciding with the availability of different prey items in the environment. Stomachs of dolphins from Texas contained a greater diversity of prey taxa, greater

numbers of prey items, and higher incidence of shrimp. We believe that some dolphins in this area feed on trash fish discarded from shrimp boats.

Inshore dolphins prey primarily on bottom-dwelling fish in shallow estuaries and bays, whereas the stomach of an offshore dolphin contained mainly cephalopods. No seasonal differences in diet were observed. Males and females exhibited essentially the same prey composition. Although bottlenose dolphins seem to have an opportunistic feeding behavior, most fish consumed were conspicuous sound producers, suggesting some selectivity in the dolphins feeding strategies.

D [1]Burn, D. 1987. Progress report of bottlenose dolphin beach surveys in the Mid-Atlantic region. NMFS/SEFC, Miami Laboratory, Coastal Resources Division Contribution ML-CRD-87/88-09.

In response to the Atlantic bottlenose dolphin die-off of 1987/88, aerial surveys were flown along the coastline from Sandy Hook, NJ to Savannah, GA, to determine the magnitude and scope of the mortality. Surveys were flown in late August, late September, and early November of 1987. Sightings of live dolphins were scarce during the first survey, clustered around Virginia Beach, VA during the second, and stretched along the barrier islands during the third. Sightings of dolphin carcasses closely followed the pattern of live animals. The spatial/temporal pattern is in agreement with the hypothesized seasonal migration of coastal bottlenose dolphins. The increase in sightings of dolphin carcasses south of Cape Hatteras, NC during the third survey may reflect delayed mortality of migrating dolphins, or the spread of a disease condition to previously unexposed segments of the population.

D [1]Burn, D. 1988. NOAA/Smithsonian Cooperative Mid-Atlantic Bottlenose Dolphin Aerial Survey Program: Final Report. NMFS/SEFC, Miami Laboratory, Coastal Resources Division, Contribution ML-CRD-87/88-23.

In response to the Atlantic bottlenose dolphin die-off of 1987/88, aerial surveys were flown along the coastline from Sandy Hook, NJ to Savannah, GA, to determine the magnitude and scope of the mortality. Surveys were flown in late August, late September, and early November of 1987, and early January and mid-March of 1988. Sightings of live animals and beached carcasses support the hypothesis of a coastal migratory stock of bottlenose dolphins. The pattern seen in the first 3 surveys suggests a southward movement of dolphins in the Autumn of 1987. The results of the fifth survey may highlight the returning northward phase of the migration.

A [3]Burn, D., D.K. Odell and E.D. Asper. in review. A mark-resighting population estimate of the bottlenose dolphin, *Tursiops truncatus*, in the Indian-Banana river complex of Florida. Submitted to IWC Special Issue on non-lethal methods for estimating cetacean abundance.

This work represents an expanded analysis of data from Odell and Asper (1982). A total of 48 bottlenose dolphins were captured and marked between November 3-21, 1980. From December 1980 through March 1982, 115 daily resighting cruises were conducted. Population estimates were calculated using the Schnabel mark-recapture method. The overall population estimate for the study area was 553 (95% CI 500-620). Seasonal population estimates show an increase in abundance during the summer months. Aerial survey population estimates show the same seasonal trends, but the magnitude of the mark-recapture estimates is about double that of the aerial survey estimates.

P [1]Burn, D. and G.P. Scott. 1988. Synopsis of available information on marine mammal-fisheries interactions in the southeastern United States: preliminary report. NMFS/SEFC, Miami Laboratory, Coastal Resources Division, Contribution ML-CRD-87/88-26.

The purpose of this report was to compile available data on incidental take of marine mammals in the southeastern US waters, in order to estimate the nature and magnitude of bottlenose dolphin/fisheries interactions. Stranding records from May, 1982 through May, 1987 were coded for various types of human interactions, including: entanglement, mutilation, gunshot, propeller wounds, broken bones, and miscellaneous interactions which did not fit into any defined category. Of these, entanglement was the most prevalent interaction, with multiple records from Virginia (8), Florida (7), and North Carolina (3). A possible interaction with the demolition of an offshore oil platform in Texas was noted for early April, 1986.

Direct observations of dolphin/fisheries interactions were sparse. Several fisheries and gear types were observed to take dolphins during the course of their operations. The overall magnitude of this take could not be determined from the data at hand.

O [2]Caldwell, D.K., and M.C. Caldwell. 1983. A field guide to marine mammals of the southeastern United States and Caribbean Basin. Prepared under Contract No, NA-82-GEA-00226.

This guide includes seals, sea lions, and manatees, as well as cetaceans. Drawings are provided for each species for easy identification. There is a brief descriptive text for each species that includes sizes, important features with especially useful ones in bold type, and expected habitat and geographical range. Several species not expected in the southeast U.S. and Caribbean are included to aid in the identification of any cetacean that might be encountered anywhere in the western North Atlantic. Tooth counts of and other information on cetaceans are provided as an aid for identification of stranded animals.

A [2]Carew, R., and S. Keer. 1981. Aerial surveys to estimate herd size and density of populations of bottlenosed dolphins. Contract Summary Report, Contract No. NA80-GA-C-00029.

This report and other survey reports by R. Carew delivered 1980-83 are the contractor's summary reports on the local aerial surveys of selected nearshore areas of the southeast United States, conducted during 1980-83. These surveys were conducted under contracts NA80-GA-C-00029, NA81-GA-C-00016, NA-GA-C-00017, NA82-GA-C-0008, and NA82-GA-C-00015. The surveys were usually of embayments, with a along shore transect just outside the embayments. The bottlenose dolphin was the primary target of the surveys. These contract reports summarize the flight time, numbers of animals seen, dates of flights, etc. For an analysis of the bottlenose dolphin sightings, see Thompson 1981a-c, 1982a-b, and Hansen and Scott, 1989.

A [2]Carter, G. 1983-6. Aircraft and data collection services in support of aerial surveys of *Tursiops truncatus* and other cetaceans in the Gulf of Mexico waters.

This report and others by G. Carter are the contractor's summary reports on the regional aerial surveys of the Gulf of Mexico, conducted during 1983-86. These surveys were conducted under contracts NA83-GA-C-00031 and NA84-WC-C-06082. The surveys covered the U.S. Gulf waters from the shoreline out to the 100 fathom isobath. The bottlenose dolphin was the primary target of the surveys, but records were kept of all mammal sightings and of all turtle sightings. These contract reports summarize the flight time, numbers of animals seen, dates of flights, etc. For an analysis of the bottlenose dolphin sightings, see Scott et al. 1989.

P [1]Clements, L.C., and D.E. Hoss. 1982. Synopsis of habitat alteration impact data on marine mammals in the NMFS southeast region. Final Report to the SEFC Marine Mammals Program.

This review of the literature on habitat alteration includes information on one marine mammal, the bottlenose dolphin, *Tursiops truncatus*. The intent of the report is to develop a list of perturbations that are known to or may impinge on the habitat of marine mammals in the southeastern United States. Habitats are briefly described and various alterations are referenced.

S [2]Duffield, D.A. 1982. *Tursiops truncatus* genetics studies: Indian River 1980-1981. Final Report Contract No. NA80-GA-C-00063.

Chromosome and enzyme profiles were obtained from blood samples taken from dolphins captured and released in the Indian River, Florida. Principle findings are the clearly non-random distribution of genotypic-types in the social units sampled as was seen in 1978 and 1979 sampling and identification of individuals with very high levels of heterozygosity indicating crosses between the two basic genotypes found in these units. These analyses would support an hypothesis of population differentiation in *Tursiops* combined in this area with a clearly discernable pattern of reproductive exchange.

S [2]Duffield, D. 1987. Investigation of genetic variability in stocks of the bottlenose dolphin (*Tursiops truncatus*) and the loggerhead sea turtle (*Caretta caretta*). Contract Report NA83-GA-C-00036.

Bottlenose dolphin: An important requirement for stock management of the bottlenose dolphin (*Tursiops truncatus*) is the definition and delineation of population boundaries, both in a geographic and a genetic sense. As a considerable number of *Tursiops* are held in display facilities in the United States, a unique opportunity exists to examine the distribution of genetic variability present in animals taken from a variety of geographic locations along the Southeastern United States and from the Pacific. This study compares allelic frequencies and levels of heterozygosity based on electrophoretic analyses of serum and red blood cell proteins for *Tursiops* representative of capture sites extending along the Atlantic coast of Florida, through the Florida Keys, to the Gulf of Mexico and in the Pacific, from Southern California through the Gulf of California. There were no discrete allelic differences between any of the collection sites. Allele frequency and genotypic profile differences provide some evidence for local sub-population differentiation, however there is evidence, as well, for gene flow between collection areas. Adequate biochemical variability exists in *Tursiops* to make this approach a useful tool for examination of the pattern of local area use by bottlenose dolphin herds and for the detection of reproductive exchanges between these groups. It is recommended that *Tursiops* stock management will require describing the sub-population structure of each region, the use of that region overtime by different groups and the evaluation of reproductive exchange between these groups.

Loggerhead sea turtle: This study was designed to test the applicability of biochemical and chromosomal variation analyses for the genetic definition of breeding stocks of the loggerhead turtle, *Caretta caretta*. Blood samples were obtained from loggerhead turtles, either as adults or hatchlings, from three different collection sites along the Southeastern Atlantic Florida coastline. Electrophoretic and chromosomal techniques used in part I. of this study were applied to these samples. No variability was detected for the 15 protein loci examined and although fluorescent R-banding of the chromosomes showed the presence of potentially variable regions in the turtle karyotype, resolution was poor from the blood preparations and variant pattern could not be resolved. These systems did not appear to have productive potential for determining spatial differentiation of stocks in *Caretta caretta*.

[3]Duffield, D., J. Chamberlin-Lea, J. Sweeney, D.K. Odell, E.D. Asper and W.G. Gilmartin. In review. Use of corneal cell culture for R-band chromosome studies on stranded cetaceans. *In* J. Reynolds and D. Odell (eds.), Proceedings 2nd Marine Mammal Stranding Workshop, Miami, Fl, 3-5 December 1987.

The prolonged viability and uncontaminated nature of corneal cells in the intact eye make the cornea a reliable source of cultured cells from post mortem animals. From corneal cell structure, a fluorescent R-band staining technique was used to look at heteromorphic (variable) regions in the karyotypes of five cetacean species which strand on United States coastlines (*Feresa attenuata*, *Pseudorca crassidens*, *Globicephala macrorhynchus*, *Kogia breviceps*, and *Megaptera novaeangliae*). All of these species had numerous heteromorphic R-band regions in their chromosomes with variants which differed in size and intensity. The distribution of heteromorphic regions in these karyotypes was compared with *Tursiops truncatus*. In *M. novaeangliae* and *T. truncatus*, extra "marker" chromosomes were noted in the karyotypes of a few individuals. The results suggest that R-band chromosome heteromorphisms, as well as the extra chromosomes, are cytogenetic markers which can be used in population studies to assess parentage and to look at regional population differences.

[2]Duffield, D. and R.S. Wells. 1987. Population structure of bottlenose dolphins: genetic studies of bottlenose dolphins along the central west coast of Florida. Contract Report 40-WCNF-00366.

This report presents the results of a preliminary evaluation of the biochemical genetics of wild bottlenose dolphins in the central west coast waters of Florida. As part of a long-term study of bottlenose dolphin population biology and social behavior, this report examines the genetic relationships within and between population units. Electrophoresis of blood proteins was used to compare a sampling of tagged and naturally marked bottlenose dolphins known to be long-term residents of the Sarasota area with a sampling of dolphins from nearby Tampa Bay and more southern Charlotte Harbor-Pine Island Sound coastal waters. Five polymorphic red blood cell protein loci were used to compare allele frequency differences between these samplings. The Tampa Bay and Charlotte Harbor-Pine Island Sound samples had similar allele frequencies, while allele frequency differences were found between these two samples and the Sarasota sample. For two of the protein loci, frequency differences were also found between the males and females of the Sarasota sample. Distributions of genotypes differed among the samples. In the Tampa Bay and Charlotte Harbor-Pine Island Sound samples there were a number of animals homozygous for a genotype that occurred with less frequency in the Sarasota animals. Homozygosity was high in the Tampa Bay/Charlotte Harbor-Pine Island Sound samples, whereas heterozygosity was high in the Sarasota sample. Based on the amount of genotypic variation in the Sarasota resident group sampled, we propose that these resident dolphins are not reproductively isolated from neighboring population units.

[1]Hansen, L.J. 1986. Dolphin aerial survey data from Florida waters April 1969-February 1971. NOAA/NMFS/SEFC/Miami Laboratory, CRD ML-86-52.

The Florida Department of Natural Resources conducted aerial surveys during 1969-1971 to determine the abundance and distribution of the Portuguese man-of-war (*Physalia physalia*). Records of dolphin sightings were also kept during these surveys. Because of the manner in which the data were collected, density estimates could not be made. The data were analyzed primarily for the sighting rate of dolphin herds in four areas of Florida coastal waters. The mean herd sizes and frequency distribution of herd sizes were similar to that of other surveys of Florida waters. The sighting rate varied significantly by season, weather, and area. The length of the flights (hours in the air each day) had a significant inverse effect on the sighting rate. Small aircraft were used for these surveys, and it seems apparent that observer fatigue was responsible for the decline in sighting rate as the length of the flight increased.

A,O [1]Hansen, L.J. in press. California coastal bottlenose dolphins. *In:* S. Leatherwood and R.R. Reeves, (eds.), The bottlenose dolphin. San Diego, Academic Press.

Photo-identification surveys, conducted during 1981-83, were used for estimating the size and other features of the southern California coastal bottlenose dolphin (*Tursiops truncatus*) population. Historical sighting records, collected during 1970-83, were reviewed for information on seasonal and daily patterns, and for effects of tidal state on group size and habitat usage patterns. The best population estimate was 240. Dolphins from the population were observed from Ensenada, Mexico, north to Monterey (over 800 km of coastline), but the normal northern end of the range was Seal Beach. About 58% of the identified dolphins were resighted, and 17% exhibited some site fidelity for the San Diego Co. area. Calves represented 7.15% of the population and were present year-round, with a peak in the fall. No seasonal patterns in group size or sighting frequency were evident, and no statistically significant daily patterns were observed in group size. Group size was larger as tide height increased, and the tidal state (ebb or flood) appeared to have an influence on habitat usage patterns. In San Diego Co., dolphins seemed to prefer the area between La Jolla and South Carlsbad, and this may have been related to a greater abundance of food resources, due to the presence of lagoon mouths and offshore kelp beds.

A,O [1]Hansen, L.J. and R.H. Defran. in review. Comparison of California bottlenose dolphin photoidentification studies. Submitted to IWC Special Issue on non-lethal methods for estimating cetacean abundance.

Different resight rates of bottlenose dolphins were obtained in separate photoidentification studies carried out in the coastal waters of north San Diego County, California. Specifically, a subset of Hansen's data showed strong site fidelity to the area while Defran's data set contained no such evidence. In an attempt to integrate the data sets possible methodological differences were evaluated and the following conclusions reached: 1) photoidentification procedures differed but both were judged effective in detecting resights; 2) survey effort did not contribute to resight differences; 3) photographic efficiency within and across surveys was comparable for both studies; 4) when Hansen's frequently sighted subset was excluded, resight rates for other identified dolphins were comparable. Thus, it appears that the observed different resight rates reflect a real shift in the site fidelity patterns displayed by some dolphins within the study area. The El Ninõ event of 1982 occurred between the studies, and probably precipitated or contributed importantly to the hypothesized shift in site fidelity patterns.

A [1]Hansen, L.J. and G.P. Scott. 1989. Bottlenose dolphin densities in five selected southeastern United States areas during 1981-83. NMFS/SEFC, Miami Laboratory, Coastal Resources Division, Contribution ML-CRD-88/89-08.

One year seasonal aerial surveys for bottlenose dolphins were conducted during 1981-83 in five areas of the southeastern U.S.: the Houma, Louisiana, area (Terrebonne and Timbalier Bays); Choctawhatchee Bay, Florida; Pensacola Bay, Florida; Key West, Florida, area; and the Savannah, Georgia, area. A single engine, high wing aircraft was used for the surveys. The data were collected in a format so as to allow density estimation with line-transect estimators. The high and low estimates (dolphins/nm^2) for each area were as follows: Houma, summer 1.477, winter 0.615; Choctawhatchee Bay, summer 1.005, spring 0.953; Pensacola Bay, insufficient sightings (2); Key West, winter 0.437, summer 0.169; Savannah, summer 1.155, winter 0.686. The variation in density by season appeared to be significant only for the Houma area.

P [2]Hersh, S.L. 1987a. Mortality, natality, migration and organismic growth rates of bottlenose dolphins (Genus *Tursiops*): a review and management considerations. Contract Report 40-GENF-700715.

For the successful management of any population, information is required not only for population size, but on the trends in size over time. The primary sources of change in population size are birth, death, and the physical movement of individuals into or out of the population (immigration/emigration). Little is known about the rates of these processes for bottlenose dolphins (genus *Tursiops*). This paper is a review of the relevant literature on these topics and on orgasmic growth rates, which directly affect birth rates through attainment of sexual maturity and which may be specific to each breeding stock.

Reported mortality rates for *Tursiops* populations vary from about 7-14%. These values fall within the range of mortality estimates for other cetaceans. Seasonal variation in mortality rates appears greater at high latitudes than in warmer regions. Studies using large sample sizes seem to indicate equal mortality rates between sexes. Mortality among younger age classes appears high relative to older animals. This pattern coincides with a "U" shaped mortality curve. Estimates of the percent calves present for *Tursiops* populations in the southeastern US waters range from 2.1-12.5%, with the majority of values clustering around 7-10%. Specific areas within a population's normal home range may be preferred nursery grounds. Very little information is available on rates of immigration and emigration. One source suggests these rates are low, on the order of 2-3%. Growth curves of *Tursiops* appear similar, although average adult body length and birth length may vary. Rapid growth occurs in the first year or two, with a gradual leveling off toward asymptotic length at about 10 years of age. Attainment of sexual maturity occurs later in males than in females. There appears to be little or no difference in adult length between the sexes, but differences in growth rates, especially during early years, need to be investigated.

S [2]Hersh, S.L. 1987b. Stock structure of bottlenose dolphins (Genus *Tursiops*) in the southeastern U.S.: a review and management considerations. Contract Report 40-GENF-700715.

Discriminating between stocks of *Tursiops* is a difficult task complicated by the uncertain systematic relationships existing at the species level. This report deals with a synopsis of the systematic literature, followed by an examination between coastal and offshore bottlenose dolphins, and observed differences between separate and coastal populations.

The systematics of the genus *Tursiops* are poorly defined, and a revision is needed. The practice of referring to all bottlenose dolphins as *T. truncatus* has led to confusion in the literature. When faced with a lack of systematic evidence which identifies specimens or populations of bottlenose dolphins as belonging to a particular species, these animals are probably best referred to as *Tursiops* spp.

In several regions of the world, 2 forms of *Tursiops* appear to occur. The larger of the two forms tends to occupy cooler and/or deeper waters than the smaller, usually coastal form. There appear to be definite morphological differences (other than size alone) between these two forms in the southeastern US. Biochemical genetics studies provide evidence for restricted reproductive exchange between coastal and offshore forms and correlate well with results of morphological studies. Apparent genetic differences have been observed among coastal populations of *Tursiops* also. The author recommends continued management of coastal groups of dolphins under the assumption of restricted genetic exchange until more is known about exchange rates and the potential effects of altering these rates.

D,P [2]Hersh, S.L. 1988a. Age class distribution of bottlenose dolphins stranded during the east coast die-off of 1987/1988. Contract Report 45-WCNF-800633.

This work was conducted as part of the SEFC's investigation of the 1987-88 dieoff of bottlenose dolphins along the U.S. east coast. Teeth were taken from bottlenose dolphins that stranded during the dieoff and ages were estimated from the number of growth layer groups in the dentine. There was no significant difference between the age class distributions from the northern and southern rages of the dieoff, and males and females of each age class were affected equally. All age classes (newborns to 25+ years old) were affected during the dieoff. Proportionately more subadult dolphin (ages 5-9) stranded during the dieoff than in previous studies.

D,S [2]Hersh, S.L. 1988b. Analysis of skull and body morphometrics of bottlenose dolphins stranded during the 1987/1988 east coast die-off. Contract Report 45-WCNF-800633.

This work was conducted as part of the SEFC's investigation of the 1987-88 dieoff of bottlenose dolphins along the U.S. east coast. Two types of bottlenose dolphins are believed to exist along the U.S. east coast: a smaller, shallow water form, and a larger, deep water form. These forms can be distinguished by differences in hemoglobin type, and comparisons of skull and body morphometrics indicate the forms differ in both size and shape. The purpose of this work was to determine if the dieoff affected both types of bottlenose dolphin. The results indicate that the observed mortality anomaly affected primarily, if not exclusively, coastal, shallow water bottlenose dolphins.

P [3]Hersh, S.L., D.K. Odell and E.D. Asper. in press. Bottlenose dolphin (genus *Tursiops*) mortality patterns in the Indian/Banana River system of Florida. *In* S. Leatherwood and R.R. Reeves, (eds.), The bottlenose dolphin. San Diego, Academic Press.

Data on sex, length, age and date of discovery were collected from 170 bottlenose dolphin (genus *Tursiops*) carcasses found beached along the Indian/Banana River system from January 1976 through December 1983. The mean number of beached carcasses per year was 19.5. Based on population size estimates in the literature, this represents minimum annual mortality of about 7-9%. Mortality appears seasonally uniform in most years and does not appear to differ according to sex. Mortality rates are apparently higher in newborn animals than in other age categories. Caution is recommended when inferring population parameters from beaching data unless reporting effort is consistent, carcass recovery rate is high and independent data on population size and structure are available.

P [3]Hersh, S.L., D.K. Odell and E.D. Asper. in review. Sexual dimorphism in bottlenose dolphins from the east coast of Florida. Submitted to Marine Mammal Science.

Skulls of 69 bottlenose dolphins (genus *Tursiops*) from the Indian/Banana River on the east coast of Florida were examined for evidence of sexual dimorphism. Results of t-tests on 28 morphological and 4 meristic skull characters indicate that males have slightly more teeth than females in all 4 arcades. Results of covariance analysis, employed to account for variation in size, indicate minor dimorphism in parietal width of the skull. Twenty body measurements of 29 *Tursiops* originating in the same area were also analyzed fort is to document the status of the Gulf of Mexico aerial survey data base. Sections on record format and data codes are provided for potential data base users. Also included is an audit trail for each survey describing data editing and quality control procedures.

A [3]Mullin, K.D. 1988. Comparative seasonal abundance and ecology of bottlenose dolphins (*Tursiops truncatus*) in three habitats of the north-central Gulf of Mexico. Ph.D. dissertation, Mississippi State Univ., Mississippi State, MS. 135 pp.

Bottlenose dolphins (*Tursiops truncatus*) were studied in 3 separate but related field investigations in the Gulf of Mexico from 1985 to 1987. The primary objective of research conducted near Chandeleur Sound, Louisiana was to determine the relationship of dolphin densities, herd behaviors, herd sizes, geometric herd formations and numbers of calf dolphins to habitat and season. Seasonal abundance and distribution of dolphins were monitored in all available habitats (salt marsh, shallow sound, gulf) for 1 year using line transect methods. The application of line transect methods was examined in detail for possible biases. Dolphin densities (dolphins/km^2) were seasonally variable within each habitat. Densities were usually largest in gulf waters (0.35 to 0.58) with a winter peak and smallest in the marsh with a fall peak (0.16 to 0.36). Seasonal herd sizes were always greatest in the gulf (6.4 to 14.6), intermediate in the sound and least in the marsh (3.7 to 5.4). Dolphin herds were distributed throughout each habitat seasonally. Dolphin herd behaviors occurred with the following frequencies: resting/milling, 39%; traveling, 24%; play/sex, 12% ; and feeding, 25%. In feeding dolphin herds, 75% were observed feeding individually with the remainder involved in cooperative feeding or feeding related to the shrimp fishery. Eight general, reoccurring dolphin geometric herd formations were recognized. A population model was constructed to predict vital population parameters based on the number of calves observed (3%).

Spring and fall aerial surveys were conducted in 7 study areas located throughout the near-shore United States Gulf of Mexico waters in 1987 in order to document the abundance and distribution of bottlenose dolphins. Spring and fall populations were estimated to be 16,892 $\pm$ 3,628 and 16,089 $\pm$ 3,338 respectively. Bottlenose dolphins were found in all near-shore waters searched.

A study was conducted to develop a correction factor for aerial survey density estimates. Aerial surveys were thought to yield negatively biased estimates compared to boat surveys. A series of comparative estimates were made in Mississippi Sound but results were inconclusive.

O [3]Odell, D.K. in review. A review of the Southeastern United States Marine Mammal Stranding Network: 1978-1987. *In* J. Reynolds and D. Odell (eds.), Proceedings 2nd Marine Mammal Stranding Workshop, Miami, Fl, 3-5 December 1987.

The Southeastern United States Marine Mammal Stranding Network was formally organized in 1977. In the decade from 1978 to 1987, network volunteers reported 2381 cetaceans, including 74 sightings of live whales, and 3 stranded hooded seals. Cetaceans included 5 species of mysticetes and 23 species of odontocetes. Florida and Texas had the most reports with 1081 and 567, respectively. The bottlenose dolphin, *Tursiops truncatus*, and the pygmy sperm whale, *Kogia breviceps*, were the most common singly stranded animals with 1472 and 224 reports, respectively. Twenty-one mass strandings of 9 species of odontocetes were reported. Seventeen of the mass strandings were in Florida, 2 in Louisiana, and 1 each in Texas and North Carolina.

Although the number of network volunteers has increased over the decade and record keeping has changed from manual to electronic, more attention must be given to the quality and quantity of data gathered, including species verification. Uniform improvement will require resources that go beyond the limits of volunteerism. Stranding networks are an almost untapped resource for gathering basic data on marine mammals.

S [2]Odell, D.K., and E.D. Asper. 1982. Live capture, marking, and resighting of bottlenose dolphins, *Tursiops truncatus*. Final Report, Contract No. NA80-GA-C-00063.

A study to collect biological data on and assess the 'discreteness' of the population of bottlenose dolphins, *Tursiops truncatus*, inhabiting the Indian/Banana River complex of the east central coast of Florida was initiated in November 1980 with the capture and marking of 49 individuals (29 males, 20 females), and recapture of 13 previously marked animals. A second cruise to recapture marked animals occurred in October 1981 and resulted in the handling of 21 marked and 2 unmarked animals. Resighting of marked animals began in December 1980 and concluded in March 1982. The resighting effort resulted in 776 sightings which included a total of 4385 animals of which 601 were marked. Other observations were made from land during inclement weather and sightings of marked animals were solicited from the public. Marked animals were never seen or reported outside the river system. This and biochemical genetics studies indicate a very discrete population. However, there may be a second population of subgroup in the southern portion of the Indian River. Morphometrics, blood chemistry, endocrinology, and microbiology were also profiled for the animals handled. There was no indication that any of the handling procedures had any observable adverse impact on the population.

S [3]Odell, D.K., and E.D. Asper. in press. Distribution and movements of freeze-branded bottlenose dolphins in the Indian and Banana Rivers, Florida. *In* S. Leatherwood and R.R. Reeves, (eds.), The bottlenose dolphin. San Diego, Academic Press.

One hundred thirty-four bottlenose dolphins (*Tursiops truncatus*) were captured, freeze-branded and released in the Indian River, Florida, between March 1977 and March 1982. During the most intensive phase of the study (August 1979 - March 1982) 74 dolphins were branded.

Twenty-eight were recaptured once and three recaptured twice. Field observations of branded animals were carried out to assess the overall movements of these animals in order to determine if this population of dolphins should be considered as a unit distinct from *Tursiops* in the nearby ocean. During over 1200 hours of field effort, 102 of the branded dolphins were seen at least once and some as many as 40 times. With rare exceptions, the branded dolphins stayed in the Indian and Banana rivers in the general vicinity of the capture sites. The length of individual ranges (north - south dimension) averaged 33 km in the Indian River. While none of the branded dolphins were ever seen or reported in the adjacent Atlantic Ocean, two dolphins moved well beyond the main Indian River study area but stayed in the Intracoastal Waterway. Since branding started in 1977, 10 branded dolphin have been found dead within the original study area. No dead branded dolphins have been found in the ocean beaches. The data on the distribution of live branded dolphins and the recovery sites of dead branded dolphins indicate that the *Tursiops* population in the Indian and Banana rivers represents a distinct unit.

P [2]Odell, D.K., and A. Schneyer. 1983. Age estimation and hormone analyses for bottlenose dolphins, *Tursiops truncatus*, from Mississippi. Final Report, Contract No. NA82-GA-C-00023.

Tooth samples for aging and blood samples for hormone analyses were collected from about 50 bottlenose dolphins captured and released in the Mississippi Sound during the summer of 1982. The animals were injected with oxytetracycline to serve as a future age marker and a precautionary antibiotic. Age/length analysis is presented and values are given for blood serum levels of testosterone, estrogen, and progesterone as appropriate for the sex of the animal. Between 5 and 9 years, males tended to show typical prepubertal levels of testosterone, which was not measurable in younger animals. Serum estradiol in females tended to increase with age with higher levels starting at approximately 5 to 6 years of age. Similarly, serum progesterone increases after age 6, and together these data indicate the onset of puberty in this population.

P [1]Owen, R.E., and G.R. Carter. 1987. Photogrammetric studies of bottlenose dolphins. NMFS/SEFC, Miami Laboratory, Coastal Resources Division, Contribution CRD-87/88-02.

This paper discusses the techniques employed to photogrammetrically measure bottlenose dolphins of the inshore and offshore waters of Cape Hatteras and of the northern Gulf of Mexico. Photographs were obtained during low-level flights over the study areas. Camera systems provided both 2-dimensional and stereo imagery. Much of the discussion deals with the sources of bias and error associated with obtaining and mensuring the images.

A,S [2]Patton, G.W., S.D. Gilliland and D.T. Gross. 1981. Marine resighting and monitoring of 25 *Tursiops truncatus* (dolphins) in the coastal area of mid-eastern Florida. Final Report, Contract No. NA80-GA-C-0041 W.

Resighting and monitoring of 25 serially tagged dolphins in the Indian/Banana River complex of Florida was performed over the period August-December, 1980. Systematic surveys by boat resulted in data for 188 dolphin herds, 74 of which contained tagged animals. Measurements and information recorded included water temperature and depth, salinity, conductivity, wind speed and direction, percent cloud cover, numbers of adults and calves, sighting cues and distance, herd and individual behaviors, herd direction and approximate speed, associated fauna and the identification (tag) number when present. One hundred seventy one photos taken of 39 of the 54 sighted tagged dolphins and all of the 12 naturally-marked animals were catalogued. The freeze-brand tagging technique was evaluated and found to be adequate for identifying individuals in a program of regular resighting effort.

R [1]Powers, J.P. (editor). 1984. Report of the second Southeast Fisheries Center stock assessment workshop.

This document summarizes the reports presented at the second SEFC stock assessment workshop. The report covers marine mammals and turtles. For bottlenose dolphins, the topics covered were: fisheries (historical and live-capture); stock structure; status of the stocks; effect of current management procedures. The report recommended continued collection of data to assess abundance and for examination of stock structure and life stage modeling. It was also recommended that assessments for monitoring abundance could be made at intervals of 5 or more years.

L [2]Reeves, R.R. and E. Mitchell. 1987. Shore whaling for right whales in the northeastern United States. Contract Report NA85-WC-C-06194.

As part of a broad review of the history of exploitation of right whales, *Eubalaena glacialis*, in the western North Atlantic, this study attempted to document the removals by shore whalers along the US Atlantic coast from Maine to Florida. In addition to an extensive literature search, which included coverage of some relevant series of newspapers, we searched sources for information on shore whaling. Data extracted from published reviews of shore whaling in New England, New York, and New Jersey were tabulated along with data from sources not previously used or cited. The resulting catch tables provide a crude and incomplete summary of removals by area and year.

The catch history for the western North Atlantic stock of right whales, as reconstructed to date, is incomplete, and any attempts to estimate early population size for comparison to the present population size must be made with caution. Beginning in the first half of the nineteenth century, there is better documentation for shore-based catches due to the availability of newspapers written for whaling readerships,

and for pelagic catches due to the relatively large surviving sample of logbooks and journals. However, by this time the period of greatest catch of Northwest Atlantic right whales was long past.

Based on the incomplete cumulative kill during 1700-1709 (at least 245 right whales), there certainly were at least some hundreds of right whales in the western North Atlantic in the late seventeenth century. There is little doubt that the kill between Nova Scotia and Florida from 1680 to 1730 was higher than could have been made from a whale population of a few hundred, which is the estimate for the western North Atlantic stock's size in recent years.

Further research should involve a more extensive newspaper search and broader regional coverage, to take account of removals from the same whale stock in eastern Canadian waters.

L [3]Reeves, R.R. and E. Mitchell. 1988. History of whaling in and near North Carolina. NOAA Technical Report NMFS 65. 28 pp.

This study aims to reconstruct the history of shore whaling in the southeastern United States, emphasizing statistics on the catch of right whales, *Eubalaena glacialis*, the preferred targets. The earliest record of whaling in North Carolina is of a proposed voyage from New York in 1667. Early settlers on the Outer Banks utilized whale strandings by trying out the blubber of carcasses that came ashore, and some whale oil was exported from the 1660's onward. New England whalemen whaled along the North Carolina coast during the 1720's, and possibly earlier. As some of the whalemen from the northern colonies moved to North Carolina, a shore-based whale fishery developed. This activity apparently continued without interruption until the War of Independence in 1776, and continued or was reestablished after the war. The methods and techniques of the North Carolina shore whalers changed slowly: as late as the 1890's they used a drogue at the end of the harpoon line and refrained from staying fast to the harpooned whale. They seldom employed harpoon guns, and then only during the waning years of the fishery.

North Carolina is the only state south of New Jersey known to have had a long and well established shore whaling industry. Some whaling took place in Chesapeake Bay and along the coast of Virginia during the late 17th and early 18th centuries, but it is poorly documented. Most of the right whales taken off South Carolina, Georgia, and northern Florida during the 19th century were killed by pelagic whalers. Florida is the only southeastern state with evidence of an aboriginal (pre-contact) whale fishery. Right whale calves may have been among the aboriginal whalers' targets.

R [1]Scott, G.P. (ed.). 1985. Report of the working group on NEFC/SEFC marine mammal research. Results of the meeting held 8-9 January, 1985. NOAA Technical Memorandum NMFS-SEFC-168. 27pp.

A two day meeting of SEFC and NEFC representatives and others was held to discuss current status of information on large whales within each Center's jurisdiction and to determine and prioritize current research needs necessary for proper management of these species. The types of information reviewed included: stock identification, present/virginal stock size, historical/present distribution, food habits/consumption, genetics, recruitment, etc. The potential impacts of human activities (fisheries, oil and gas, pollution, etc.) were evaluated and prioritized by species. The resulting report provides an outline of research needs to guide future coordinated research efforts on large whales in the Northeast and Southeast Regions. Overall, human activities were estimated to have the greatest potential impact on right whales, the least on blue whales.

L [1]Scott, G.P. 1988. Precision of cetacean pilot survey abundance indices from the 1986/87 AMLR krill survey cruise. NOAA/NMFS/SEFC/Miami Laboratory, Coastal Resources Division Contribution No. CRD-87/88-33.

Correlation of interannual variations in the Antarctic predator community with variations in the prey field (krill) is an objective of AMLR. The ability to meet this objective is a function of the degree of interannual population variation that can be detected in both the predator and prey fields. This note is directed at assessment of the degree of change detectable in minke whale relative abundance by analysis of the variation in indices of abundance estimated from data collected during a pilot sampling survey for cetaceans on board hydroacoustic cruises for krill. The data analyzed indicate that changes in minke whale abundance within the AMLR sampling area likely need to be >35% between sampling periods, in the best case, for the sampling techniques applied to detect "significant" differences between intersample index values.

R [1]Scott, G.P. in press. Management oriented research on *Tursiops truncatus* at the Southeast Fisheries Center. *In:* S. Leatherwood and R.R. Reeves, (eds.), The bottlenose dolphin. San Diego, Academic Press.

Since the Marine Mammal Protection Act (MMPA) of 1972 came into force, more than 440 bottlenose dolphins, *Tursiops truncatus*, have been permanently removed from the wild for public display and scientific research. Most were taken from the coastal marine waters of the southeastern United States. The National Marine Fisheries Service is the agency responsible under the MMPA for management of the live-capture fishery and the Southeast Fisheries Center (SEFC) is responsible for developing management recommendations for the fishery in southeastern U.S. jurisdictional waters. Annual allowable take for the seven management areas in the southeast is based on the 2% quota rule recommended by the Marine Mammal Commission and on the conservative assumption that the population of bottlenose dolphins in the region consists of numerous genetically isolated, local stocks and seasonally sympatric, transient stocks. The assumption is supported by the results of research on local abundance, dynamics of herds, and biochemical genetics of this species. Current SEFC research on bottlenose dolphins is directed at further testing of the stated assumption and evaluating the 2% quota rule. The current research includes analysis of distribution and abundance patterns in selected regions, photogrammetric analysis, and further studies of biochemical genetics and herd dynamics.

R [1]Scott, G.P., J. Begnigno, R. Brumstead, R. Ford, R. Gracy and P. Montanio. 1982. Summary of completed and on-going work related to the conservation and protection of possible local populations of bottlenose dolphins in the southeast United States.

The information presented in principally tabular format represents a summary of ongoing and completed research directed at the conservation and management of *Tursiops truncatus* in the Southeast region. The summary is centered on NMFS-sponsored research and research sponsored by other agencies, but which has been used in the development of the SEFC Marine Mammal Program and for management recommendation for *T. truncatus*. As such, the summary does not include all research conducted on *T. truncatus*. The report is divided into six sections as follows: existing management scheme, nature and results of local surveys, nature and results of marking/tagging studies, nature and results of other relevant studies, nature and extent of take, and reports/publications/references.

D,A [1]Scott, G.P.and D.M. Burn. 1987. The potential impact of the 1987 mass mortality on the Mid-Atlantic offshore stock of bottlenose dolphins. NMFS/SEFC, Miami Laboratory, Coastal Resources Division Contribution ML-CRD-87/88-10.

During the summer months of 1987, an unusually high number of bottlenose dolphins, *Tursiops truncatus*, stranded on the beaches from New Jersey to the Carolinas. As part of the multi-agency investigation, the National Marine Fisheries Service initiated an aerial sampling survey of the Mid-Atlantic region in late August, 1987. The objective of this survey was to collect information for comparison with baseline data, to allow for an assessment of the impact of the mortality on dolphin populations.

The study area was based on survey blocks "G" and "H" modified from the Cetacean and Turtle Assessment Program (CETAP) into nearshore and offshore strata. The approximate area surveyed included waters from the barrier islands to the 1000 fathom isobath, from northern New Jersey to the Virginia/North Carolina border. Nearly 1200km of trackline was surveyed over a total of 3 suitable sampling days. In the near-shore stratum, 2 "on-effort" and 3 "off-effort" dolphin sightings were recorded. By comparison, in the offshore stratum, a total of 10 "on-effort" and 2 "off-effort" dolphin sightings were recorded. Densities computed from these values suggest the offshore density is 4 or more times that of the inshore.

Under the stated assumptions of this analysis, the evidence suggests that in the offshore stratum, there is approximately a 60% chance of a decline in the population abundance index in the offshore stratum. Data were insufficient for a valid comparison for the inshore stratum.

D,P [1]Scott, G.P., D.M. Burn, L.J. Hansen. 1988. The dolphin dieoff: long term effects and recovery of the population. Proceedings: Oceans '88. IEEE Cat. No. 88-CH2585-8. Vol. 3:819-823.

The 1987-88 mortality of bottlenose dolphins (*Tursiops truncatus*) along the U.S. Atlantic coast was an order of magnitude greater than the prior three year average primarily due to an apparent disease epidemic. Although both coastal and offshore stocks of dolphins are believed to inhabit the waters off the east coast, population surveys and biological samples from stranded and live-captured animals suggests that the observed mortality was principally from a mid-Atlantic coastal, migratory stock of dolphins. Available data suggest a decline of at least 53% in the stock abundance may have occurred. If this degree of reduction has occurred and this stock proves to be reproductively isolated, then the stock is likely below its optimum sustainable population (OSP) level, and thus a depleted stock. Population trajectories from a 53% reduction level were simulated using a range of vital rate and other demographic parameter values. Under the parameter assumptions used for calculations, no combinations resulted in trajectories toward extinction. The resulting distributions of recovery time to the lower limit of OSP were strongly skewed. In the absence of human-induced mortality, the median time to recovery was 32.5 yr (range, 14-90 yr). Under the assumption of a constant human-induced mortality rate equal to estimates of pre-event rates, the time to recovery estimates ranged from 18 to 100+ yr with a median time to recovery of 50.5 yr. In more than 20% of the cases simulated with human-induced mortality, recovery was not achieved within 100 yrs.

A [1]Scott, G.P., D.M. Burn, L.J. Hansen and R.E. Owen. 1989. Estimates of bottlenose dolphin abundance in the Gulf of Mexico from regional aerial surveys. CRD-88/89-07.

Aerial sampling surveys of the US Gulf of Mexico waters were conducted between September, 1983 and February, 1986. Seasonal sampling of the 359,000km^2 study area was completed to allow estimation of region-wide abundance of bottlenose dolphins (*Tursiops truncatus*). Under the assumption of no net movement between sampling regions and sampling periods it was estimated on average between 35,000 and 45,000 bottlenose dolphins may live in US Gulf of Mexico waters of depths 183m or less. The dominant proportion of these animals appear to inhabit waters of greater than 18.3m. The data were stratified to allow estimates sufficient for quota recommendations for managing the live-capture fishery for bottlenose dolphins in the Gulf of Mexico.

R [1]Scott, G.P., L.J. Hansen and D.M. Burn. 1988. Preliminary report on: status of bottlenose dolphin stocks in the US Gulf of Mexico and US Atlantic Ocean. CRD-87/88-23.

The purpose of this report is to present an overview of the status of bottlenose dolphin stocks in the US Gulf of Mexico and US Atlantic Ocean. The document includes sections on stock differentiation, spatial and temporal distribution, existing population levels, incidental take by commercial fisheries, optimum sustainable population (OSP), and impact of incidental take. In many areas, information was generally scarce, particularly regarding existing population levels and OSP determination. Of particular interest are the sections on incidental take by commercial fisheries, which suggest that several fisheries may have a detrimental effect on bottlenose dolphin populations, and in the case of the Atlantic coastal migratory stock, may have a delaying effect on the recovery of this stock.

L [3]Scott, G.P., R.D. Kenney, R.E. Owen, M.A.M. Hyman and H.E. Winn. 1985. Biological and physical oceanographic correlatives to cetacean density distribution in the Great South Channel. ICES. C.M. 1985/.N:6.

The Great South Channel (GSC) has been shown to be a high-use area for cetaceans off the New England coast. Aircraft- and ship-based sampling was used to characterize this region during the spring of 1981 to allow a correlative analysis of the factors which may influence the observed marine mammal biomass density distribution.

The bathymetry of the area is hypothesized to induce upwelling of southerly flowing Gulf of Maine intermediate water over the 100m sill of the GSC. Above-surface IR sensor data and surface chl-a, phytoplankton biomass, and chlorophyll fluorescence indices were lower upstream of the observed surface thermal front while zooplankton and cetacean biomass densities were higher. Hydroacoustic samples and 333*u* bongo net samples suggest a densely packed prey biomass concentrates on the bottom water layer upstream of upwelling at depths of 123-135m. The zooplankton observed in the GSC during May was principally stage V *Calanus finmarchicus*, with densities ranging to 6 times those previously reported in the Gulf of Maine. It was inferred that the high cetacean biomass observed in the GSC area was in response to prey concentration in the area that resulted from the interactions of upwelling and prey behavior.

L [3]Scott, G.P., R.D. Kenney, T.J. Thompson and H.E. Winn. 1983. Functional roles and ecological impacts of the cetacean community in the waters of the northeastern U.S. continental shelf. ICES C.M. 1983/N:12.

This analysis was directed at quantifying the functional role of the cetacean community in the four major marine ecosystems off the northeastern U.S. coast (Gulf of Maine, Southern New England and Mid-Atlantic Bight). Biomass density distributions and diversity indices suggest distinct differences between the systems identified. Ichthyophagous cetaceans were found to dominate the total biomass throughout, however, planktonophagous cetaceans proved to be significant consumers on Georges Bank and in the Gulf of Maine, and teutophagous cetaceans were significant in the Southern New England, Mid-Atlantic Bight and Georges Bank systems. Temporal differences in regional utilization, reflecting migratory behaviors and principal prey item distributions were also observed. Estimates of total annual consumption of finfish, squid, and zooplankton indicate the large energetic demands that cetaceans place on the systems. Cetacean gross biomass production was estimated to represent about 14.5% of the estimated annual rate of finfish production on Georges Bank. Estimates of the energetic demands of the cetaceans on the three ecosystems were used in a simplified trophic model to evaluate energy flow to the cetacean biomass. The model results in cetaceans accounting for at least 9.5 - 31.0% of the measured primary productivity in the system. The nitrogen recycling contribution by cetaceans was found to be relatively minor compared to zooplankton and physical contributions to the N-flux on Georges Bank and in the Gulf of Maine. Cetacean density distribution data suggest that N fluxes ranging to 1.83 x 10^9 ug-at N/sec may have significant impacts on

small regions within the systems. These levels of consumption and recycling lead to the inference that the functional role cetaceans play in the systems is not small, and that this biomass needs to be considered in multispecies fisheries management models.

A,S [2]Shane, S.H. 1987. Bottlenose dolphin abundance and individual home range patterns: Sanibel Island, Florida. Contract Report 40-WCNF-502401.

This paper discusses the abundance and home range patterns of bottlenose dolphins around Sanibel Island, Florida. The abundance estimates and calculations of home range are based upon photoidentification of 126 recognizable individuals during April 1985 to May 1986. The population size was estimated by estimating the proportion of identified dolphins in a typical pod. This proportion was determined using a subsample of pods which met certain criteria. The resulting proportion was used to calculate the total population size. The population size was estimated to be 286 (95% CL = 224-397). Home range patterns were evaluated by mapping out where each identified dolphin was found. Home ranges were estimated for 17 dolphins and varied from 15 to 65 km^2 with an average size of 35.4 km^2.

A,P [2]Smith, O.B. and G.W. Patton. 1988. Aerial surveys of the Indian/Banana Rivers bottlenose dolphin population: initial analysis. Interim data analysis report, Contract 50-WCNF-7-06152.

In 1987, the SEFC initiated a three-year, low-level monitoring study of the Indian/Banana Rivers bottlenose dolphin population. The monitoring is designed to be able to detect a major change in the population size (other than seasonal). Aerial surveys are being conducted seasonally. The data collection is being done under contract, and this reports summarizes the contractors activities during the first six months of the contract. The report also details the data collection methods.

S,P [2]Solangi, M.A., and G.E. Dukes. 1983. Atlantic bottlenose dolphin, *Tursiops truncatus* herd studies in the Mississippi Sound, U.S.A.,: capture, freeze marking and biological sampling. Final Report, Contract No. NA82-GA-C-00023.

The purpose of this study was to (1) collect, mark, obtain biological data from and release 50 Atlantic bottlenose dolphins in the Mississippi Sound and (2) to establish a database for blood chemistry, microbiology, age, genetics, endocrinology, and morphometrics for dolphins inhabiting the Sound. The report provides information on collection of dolphins and sampling techniques, and tables of the results.

R [1]Staff, 1986. Synopsis of marine mammal research conducted at the SEfC since 1983. NOAA/NMFS/SEFC/Miami Laboratory.

This reports reviews the research efforts which the SEFC had conducted to address the three main goals of the marine mammal program: 1) assessment of bottlenose dolphin abundance, 2) stock identification of bottlenose dolphins, and 3) life stage modeling of bottlenose dolphins. The reports also includes the efforts directed at large whale research.

D,R [1]Staff. 1988. The bottlenose dolphin 1987-88 mortality event impacts and options. NOAA/NMFS/SEFC/Miami Laboratory.

This document reviews available information on the bottlenose dolphin dieoff of 1987-88 and makes recommendations for future research to address the various aspects of the dieoff. The recommendations included: large scale and small scale abundance estimation surveys to assess current population levels and quantify before and after effects; continued stranding recovery to monitor mortality and disease patterns; an extensive effort to examine causes and correlates of the disease. The report also provides a rough approximation of dollar amounts necessary to conduct the proposed research.

R [1]Staff. 1989. Quota recommendations for removals of bottlenose dolphins in southeastern waters. NOAA/NMFS/SEFC/Miami Laboratory, CRD-88/89-09.

Since the inception of the Marine Mammal Protection Act (MMPA) of 1972, over 500 bottlenose dolphins (*Tursiops truncatus*) have been permanently removed from the wild gene pool in the southeastern US waters for public display and scientific research purposes. The live-capture fishery dates to at least 1914 and is thought to be the longest sustained fishery of its type in the world. At least 1,170 bottlenose dolphins have been removed from the southeastern US since the early 1900's. The magnitude of annual removals due to other human-induced causes such as incident catch in other fisheries, and shooting of nuisance dolphins is not well documented.

Marine mammal research at the Southeast Fisheries Center was started in 1978 in response to the requirement for dolphin live-capture fishery management advice. Information necessary for estimating stock status relative to optimum sustainable population levels has generally been lacking. Recommendations for live-capture quotas have been based on the best available information relating to the bottlenose dolphin population abundance, stock structure, and productivity of the region.

The purpose of this document is to provide an updated review of the available information on bottlenose dolphin stocks in the southeast and of the quota system presently in place. The manuscript is organized into 4 sections dealing with the following subject matter: 1) updated assessment of minimum population levels; 2) review of the current procedure which allows an annual take of 2% of the minimum population level from each quota area (2% rule); 3) review of the total take by year and area; and 4) quota recommendations.

A [1]Thompson, N.B. 1981a. Estimates of abundance of *Tursiops truncatus* in Tampa Bay, Florida. NOAA/NMFS/SEFC/Miami Laboratory, Fishery Data Analysis Division Technical Report.

Independent seasonal aerial surveys of the study area were completed. The same aircraft type and survey design were used in during all surveys. These surveys yield negatively biased population estimates because the trackline is not observed directly. All estimates are considered specific in time and space and cannot simply be expanded to represent a comprehensive estimate of *Tursiops* abundance in southeast U.S. waters.

A [1]Thompson, N.B. 1981b. Estimates of abundance of *Tursiops truncatus* in Charlotte Harbor, Florida. NOAA/NMFS/SEFC/Miami Laboratory, Fishery Data Analysis Division Technical Report.

Independent seasonal aerial surveys of the study area were completed. The same aircraft type and survey design were used in during all surveys. These surveys yield negatively biased population estimates because the trackline is not observed directly. All estimates are considered specific in time and space and cannot simply be expanded to represent a comprehensive estimate of *Tursiops* abundance in southeast U.S. waters.

A [1]Thompson, N.B. 1981c. Estimates of abundance of *Tursiops truncatus* in the Indian-Banana River Complex, Florida in 1980. Page 118 *In:* Abstracts, Fourth Biennial Conference on the Biology of Marine Mammals, San Francisco, California, Dec 14-18, 1981.

NMFS supported aerial surveys of the Indian-Banana River complex were completed in May, August, and November, 1980 with the purpose of estimating the abundance of *Tursiops truncatus* in this area. All surveys were conducted in side viewing aircraft which prohibit direct observation of the trackline. Line transect methodology assumes the trackline is observed. Alternative ways of dealing with violation of this assumption were used including use of a uniform distribution of right angle sighting distance; rescaling the detectability curve; and correcting after model selection. Estimates of the f(0) were selected using the rescaled data. Estimates of abundance derived from fitting a Fourier series to the rescaled data are, with 95% confidence intervals: 206 (± 174) for May; 435 (± 172) for August; and 202 (± 106) for November, 1980.

A [1]Thompson, N.B. 1982a. Estimates of abundance of *Tursiops truncatus*, the bottlenose dolphin in: St. Joseph-Apalachicola Bays, Florida; Mississippi Sound, Mississippi; and the Aransas-Copano-San Antonio Bay complex, Texas. NOAA/NMFS/SEFC/Miami Laboratory, Fishery Data Analysis Division Technical Report.

Independent seasonal aerial surveys of the various study areas were completed. The same aircraft type and survey design were used in each sampling area. These surveys yield negatively biased population estimates because the trackline is not observed directly. All estimates are considered specific in time and space and cannot simply be expanded to represent a comprehensive estimate of *Tursiops* abundance in southeast U.S. waters.

A [1]Thompson, N.B. 1982b. Estimate of abundance of *Tursiops truncatus* in Corpus Christi Bay, Texas, September, 1979. NOAA/NMFS/SEFC/Miami Laboratory, Fishery Data Analysis Division Technical Report.

Independent seasonal aerial surveys of the study area were completed. The same aircraft type and survey design were used in during all surveys. These surveys yield negatively biased population estimates because the trackline is not observed directly. All estimates are considered specific in time and space and cannot simply be expanded to represent a comprehensive estimate of *Tursiops* abundance in southeast U.S. waters.

R [1]Thompson, N.B. 1982c. Assessment of stocks of *Tursiops truncatus* in the southeast U.S.: a review. NOAA/NMFS/SEFC/Miami Laboratory, Fishery Data Analysis Division Technical Report.

This document reviews the information needs as of July 1982 for management of the bottlenose dolphin live-capture fishery in the U.S. Gulf of Mexico. The available information for the following population parameters was discussed: stock separation, population productivity, and population sizes.

P [1]Thompson, N.B. in review. Investigation of the seasonality of calving in the bottlenose dolphin, *Tursiops truncatus*, using aerial survey data. Submitted to U.S. Fish. Bull.

Aerial survey sightings of *Tursiops truncatus* were collected during seasonal surveys over various study areas along the southeast U.S. coast. When possible,, animals were identified as adult, juvenile, and calves based on relative size. All adults and juveniles were considered non-calves for the purpose of this paper. Measures used to test for differences between months, and between inshore and offshore flights include: total calves sighted; calves/herd; and proportion of calves sighted relative to the total number of animals sighted. While there were no significant differences found in the Indian/Banana River, Florida, differences were found between inshore and offshore flights and between months at the other four survey areas. These differences suggest that there may be a distinct calving season, in conjunction with significant inshore-offshore movements of *Tursiops*.

S [2]Toom, P.M. 1983. Serum protein and hemoglobin electrophoretic profiles in *Tursiops* from the northern Gulf. Final Report, Contract No. NA82-GA-C-00023.

Serum protein and hemoglobin electrophoretic profiles were obtained for some of the 50 bottlenose dolphins captured and released in the Mississippi Sound during the summer of 1982. Abnormal hemoglobin profiles were noted for three animals. Some comparisons are made with the profiles obtained for animals sampled in the Indian/Banana Rivers, Florida.

S [2]Wells, R.S. 1987. Population structure of bottlenose dolphins: behavioral studies along the central west coast of Florida. Contract Report 40-WCNF-00366.

This report presents updated information from a study initially begun in 1970 on the west coast of Florida. The study area extends from St. Petersburg to Fort Meyers Beach, and includes large bays with their associated channels and shallow grassflats. Animals were captured and marked on three occasions: 1970-71 (12), 1975-76 (47), and 1984-85 (70). Information gathered during resighting cruises distinguished three dolphin communities within the study area: Gulf, Passage Key Inlet to Tampa Bay, and Sarasota. To test the biological significance of these community designations, information on the genetic composition of each of the units was required. To this end, blood samples from 30 dolphins from the Sarasota community and 6 from southern Tampa Bay were analyzed electrophoretically. Genetic differences suggested that there was a biological significance to the behavioral community designations. However, strong genetic heterozygosity within the Sarasota community indicate that it was not a closed reproductive unit. Evidence suggests that males are the most likely vector for genetic exchange.

Long-term observations of the Sarasota community facilitated the characterization of some of the features of its structure, including site fidelity and habitat use, community size, age, and sex composition, and group structure. Long-term residency is evidenced by resightings made in the same area over as many as 15 years. Habitat preference appears to vary seasonally within this community. Adult males travel from female school to female school. The size of the Sarasota community seems to have been relatively stable over many years of the study, averaging somewhere around 100 animals. The community was comprised of a number of schools at any given time, with age and sex being important determinants of school composition.

Discreteness of dolphin communities is considered a function of three process: mixing between communities, emigration, and immigration. Most of the mixing occurred around the periphery of the Sarasota

community's range. Also, mixing involved both sexes of Sarasota dolphins, but males were involved predominantly. Emigration, or disappearance of a regular member from a given dolphin community, was estimated at 2-3% per year. Immigration, or appearance of a previously unknown animal, is also relatively low, estimated at 3.2% per year.

O [3]Wells, R.S., L.J. Hansen, A.B. Baldridge, T.P. Dohl, D.L. Kelly and R.H. Defran. in press. Northward extension of the ranges of bottlenose dolphins along the California coast. *In:* S. Leatherwood and R.R. Reeves, (eds.), The bottlenose dolphin. San Diego, Academic Press.

This paper examines a long-distance shift in the range of resident dolphins from southern California in apparent response to significant changes in water temperature. During the El Ninõ warm-water incursion of 1982-83, bottlenose dolphins were identified as far north as Monterey Bay and vicinity, more than 600 km to the north of their normal range. Some dolphins returned to southern California, while others continued to use waters to the north of their previous range. Association patterns observed in southern California waters were maintained while the identifiable animals were in Monterey Bay. The distance traveled by these dolphins constitutes the longest documented movements for this species. The unusual shift in movement patterns underscores the behavioral flexibility of the species, suggests a mechanism for range expansion, provides new information on the stability of social associations between dolphins, and offers a possible explanation for the historical record of specimens in waters well to the north of the species' present "normal" distribution.

P,S [2]Wells, R.S. and M.D. Scott. 1988. Estimating bottlenose dolphin population parameters from individual identification and capture-release techniques. Contract Report 50-WCNF-7-06083.

In 1987, the SEFC initiated a three-year, low-level monitoring study of the Sarasota/Tampa Bay bottlenose dolphin populations. The monitoring is designed to be able to detect a major change in the population size (other than seasonal). This work is being conducted under contract. The first report due was a synopsis of all previous work that could be applied to examine the parameters outlined in the contract: population size, natality, mortality, emigration and immigration. A modified version of the abstract follows: Field studies begun in 1970 and continuing to date have identified at least three adjacent resident communities of bottlenose dolphins along the central west coast of Florida. We have used photo identification, mark-recapture techniques, behavioral observations, radio-tracking, and brief captures for biological sampling to examine the structure and dynamics of these communities. Community designations are based on consideration of individual home ranges, social association patterns, and genetics. Though the communities are relatively discrete in terms of ranges and associations, electrophoretic analyses of blood samples indicate that genetic exchange occurs between communities. Males travelling between communities appear to be the probable vectors for genetic exchange. Most of our field efforts have been concentrated on the Sarasota dolphin community. Most of the members of the Sarasota community are identifiable from natural marks or tagging efforts over the last 18 years. This community consists of about 100 individuals. For the analyses presented here, we considered 116 dolphins identified during 1980-1987. Of these, 83 are of known sex and 56 are of known age. The long time span of the study and the high proportion of identifiable community members has allowed us to estimate vital rates for this community and to test the accuracy and precision of mark-recapture methods. An annual recruitment rate of 4.9% was offset by a minimum mortality rate of 1.2%; the mean fecundity rate was 14.3%. Knowledge of maternal relationships allowed comparisons of the percentage calves observed in the field vs. the percentage of young of the year. Because of the prolonged period of association between mothers and calves, there were nearly six times as many mother-calf pairs as mothers with young of the year.

O [3]Wells, R.S., M.D. Scott and A.B. Irvine. 1987. The social structure of free-ranging bottlenose dolphins. *In* H.H. Genoways (ed.), current mammalogy. Plenum Press, New York and London. pp. 247-305.

This chapter summarizes the work to date that the authors initiated in 1970 in the Sarasota, Florida area. The research program consists of two main methods: 1) temporary captures for marking, measurements, and biological sampling, and 2) observations, including radiotracking, photographic identifications censuses, and focal animal observations. The social structure of the Sarasota bottlenose dolphins is characterized as is the home range for these animals. Information is provided on the dolphin community demography, social unit characteristics, individual association patterns, and mating and rearing systems. Similarities between the dolphin social structure and that of the Serengeti lion are discussed.

S,P [2]Wells, R.S., M.D. Scott, A.B. Irvine and P.T. Page. 1981. Observations of bottlenose dolphins, *Tursiops truncatus*, marked during 1970-1976, on the west coast of Florida. Final Report, Contract No. NA80-GA-A-195.

Small boat surveys were conducted through the Sarasota, Florida area during April, September, and October, 1980. Photographs were used to identify individual bottlenose dolphins. Observations indicated that members of the herd were resident to the area for at least 10 years. The resightings of 74% of the dolphins within the same areas as they had been seen 4-10 years before suggested that the herd was relatively stable in composition and range. Rough population size estimates and the proportion calves in 1980 were similar to previous estimates. Dolphins within the study herd associated with many of the same individuals in 1980 as in earlier studies.

L [3]Winn, H.E., J.H.W. Hain, M.A.M. Hyman and G.P. Scott. 1987. Chapter 13: Whales, dolphins, and porpoises. *In:* R. Backus (ed.), Georges Bank. The MIT Press. pp. 375-382.

This chapter briefly describes the distribution, abundance, and role in the ecosystem of the 12 common species of cetaceans which inhabit Georges Bank on a regular or seasonal basis. During spring and summer, the seasons of apparent peak abundance, there may be on the order of 29,000 individual cetaceans present, representing a biomass of about 25,000 metric tons. These top predators consume a quantity of food comparable to, or perhaps greater than that taken from Georges Bank by man. The Atlantic white-sided dolphin (*Lagenorhynchus acutus*) is the most abundant small cetacean, and the fin whale (*Balaeoptera physalus*) the most abundant large cetaceans. During the spring, fin whales account for some 42% of the total cetacean biomass of Georges Bank.

Appendix IV

Marine Mammal Commission letter of 12 April 1989 to N. Foster.

MARINE MAMMAL COMMISSION
1625 EYE STREET, N.W.
WASHINGTON, DC 20006

12 April 1989

Nancy Foster, Ph.D.
Director, Office of Protected Species
and Habitat Conservation
National Marine Fisheries Service
1335 East West Highway, Room 8268
Silver Spring, MD 20910

Re: Permit Application No. 435
(Ouwehands Dierenpark)

Dear Dr. Foster:

Thank you for providing the Commission a copy of the Service's notice of a public hearing to be held on Tuesday, April 18th, to solicit additional information on the application submitted by the Ouwehands Dierenpark, Rhenen, The Netherlands. The applicant requests a permit authorizing the capture in the Gulf of Mexico, and subsequent transport, export to The Netherlands, and maintenance of four bottlenose dolphins (Tursiops truncatus). Since information put forward during the hearing may affect this and future permit applications regarding bottlenose dolphins, the Commission is suspending consideration of permit application No. P-435 and future applications to take bottlenose dolphins from the Gulf of Mexico until the hearing has been held, information put forward therein evaluated, and the Service has completed and provided the Commission its assessments of: (a) the status of the affected dolphin stocks; and (b) the effectiveness of the Service's special management and research programs to insure that the stocks are not disadvantaged by such taking.

Among other things, the assessments should include evaluation of:

1. the appropriateness of the geographic management units currently being used--i.e., are the units (the Indian/Banana River complex, Crystal River-Charlotte Harbor, etc.) geographically the best given the available information on the demography and discreteness of bottlenose dolphin stocks along the Atlantic and Gulf coasts of the United States, and do the units recognize the possibility of there being discrete inshore and

offshore stocks as well as resident and transient populations in certain coastal areas?

2. the assumption that each designated management stock is near the upper limit of its optimum sustainable population range (i.e., near its carrying capacity level), and will not be reduced below its maximum net productivity (MNP) level as long as the annual removal from the stock is two percent or less of the minimum estimated stock size--e.g., is it possible that taking for public display and scientific research, either by itself or in combination with the incidental take in fisheries and other forms of taking or mortality, may have caused one or more stocks to be reduced below its MNP level?

3. the adequacy of existing stock estimates and monitoring programs--e.g., are the data used to estimate stock size reliable and unbiased, are available estimates of minimum stock size sufficiently recent and accurate to lead one to be confident that they provide reasonable approximations of current stock size, and are ongoing and planned monitoring programs sufficient to detect 10, 15, or 20 percent decreases in stock size?

4. the adequacy of existing incidental take data and planned or proposed report verification programs--e.g., does available information provide a reliable indication of the number, ages, sex, and stock identity of bottlenose dolphins being taken incidentally in Gulf and Atlantic coast fisheries and the effects of this and other forms of take and mortality on the various dolphin stocks, and will reporting and report verification programs being developed in response to the 1988 Marine Mammal Protection Act amendments provide the information necessary to accurately determine and detect changes in incidental take rates?

5. the theoretical merits and practical value of the two percent rule--e.g., is there sound justification for assuming that the net annual increment of bottlenose dolphin populations at or near their MNP level is substantially greater than two percent, and should a different percentage be used if the removals are mostly young females as seems to have been the case at least in some areas? and

6. the possible effects of chase and capture--e.g., how many porpoise are pursued and captured each year, on the average, in each of the designated management areas, and what if any effect does chase and capture have on survival and reproduction?

We look forward to receiving the Service's assessment of its bottlenose dolphin research and management programs.

Sincerely,

John R. Twiss, Jr.
Executive Director